THE PRINCIPLES AND PRACTICE OF DENTISTRY

INCLUDING

ANATOMY, PHYSIOLOGY, PATHOLOGY, THERAPEUTICS, DENTAL SURGERY AND MECHANISM.

BY

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WITH TWELVE HUNDRED AND FIFTY ILLUSTRATIONS.

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There are two forms of hemorrhage—the "primary," which immediately follows the extraction of a tooth, and the "secondary," which occurs after the arrest of the primary. A patient may have a tooth extracted during the day, and no unusual hemorrhage result, which is the common experience; but during the night, or the next day, or even later, a serious flow of blood may ensue, which is secondary hemorrhage, and more difficult to arrest than the primary form. Of the many cases which have fallen under our own observation, we shall mention only the following:—

In the fall of 1834 Miss I., fifteen years of age, had the second molar on the left side of the upper jaw removed. The hemorrhage immediately after the operation was not greater than usually occurs, and in the course of half or three-quarters of an hour it ceased altogether. But at about twelve o'clock on the following night it commenced again, the blood flowing so profusely as to excite considerable alarm. A messenger was immediately sent to ask our advice, and we directed that the alveolar cavities should be filled with pledgets of lint, saturated with tincture of nutgalls. Two days after, at about six o'clock in the morning, we were hastily sent for by the young lady's mother, and when we arrived at her residence we were informed that the bleeding had been going on for about four hours. During this time more than two quarts of blood had been discharged. The blood was still oozing very fast. After we had removed the coagulum we filled the socket with pieces of sponge, saturated, as the lint had been, with tincture of nutgalls. When firmly pressed in and secured by a compress, the hemorrhage ceased. These were permitted to remain until they were expelled by the suppurative and granulating processes. We afterward had occasion to extract one tooth for a sister and two for the mother of the young lady, and a hemorrhage similar to that just described occurred in each case. Where the tendency to hemorrhage exists, due care should be exercised, immediately after the extraction of teeth, to guard against its occurrence by the application of a reliable styptic. Some of the more simple local remedies for its arrest are spider-web as a mechanical obstructor; also compressed sponge saturated with sandarac varnish or coated with soft wax; the return of single-root teeth, coated with wax, to the cavity; the lint of black silk, owing to the efficacy of the coloring matter; the scrapings of leather, on account of the tannin used in preparing it; lint of old linen, saturated with phenol sodique, all of which may be packed into a bleeding cavity after freeing it from blood, and kept in place, if necessary, by a compress; also the adaptation of a rubber plate accurately to the part, or of modeling composition as compresses for the retention of the styptic; also alum; also matico leaf, prepared by

immersing a piece in water for a few minutes and rolling it into pellets, or into a cone, with the under surface of the leaf outward, and packing these into the cavity, after which a compress is applied, and also a bandage round the head and under the chin to keep the mouth at rest. The more powerful styptics for local application consist of tannic acid, gallic acid, nitrate of silver, tincture perchlorid of iron, solution of persulphate of iron, powdered subsulphate of iron. A styptic and antiseptic cotton is prepared by saturating purified cotton with tannic acid five parts, carbolic acid four parts, and alcohol fifty parts; the cotton is dried and preserved air-tight. Tannin is an excellent styptic, and answers well in connection with the compress of lint or cotton in most cases, also gallic acid, and their clots are not soluble in the blood. The tincture perchlorid of iron and the solution persulphate of iron, although powerful styptics, are not reliable, on account of the danger of sloughing and the occurrence of secondary hemorrhage. The same is the case with the nitrate of silver, the use of which, although it may prove successful in some cases, is attended with destruction of tissue, and its clot is soluble in the blood. The powdered subsulphate of iron (Monsel's) applied to the bleeding cavity on pledgets of cotton saturated with sandarac varnish, with a compress so adjusted as to act directly upon the mouth of the bleeding vessel, will generally prove effectual in arresting alveolar hemorrhage. The compression should be moderate, and the packing be allowed to remain until all danger of a return of the bleeding is past. In many cases of severe alveolar hemorrhage it is better to allow the packing to come away of itself. Constitutional treatment is frequently necessary in connection with the local treatment, and such internal remedies as acetate of lead, two grains; opium, one grain; tincture of perchlorid of iron, ♏ xv–xxx; gallic acid, gr. v–x; tincture of erigeron canadensis, gtt. j, every minute; dilute hydrochloric acid, gtt. xv in a wineglass of water every four hours, will prove serviceable in obstinate and severe cases. Veratrum viride, in doses of gtt. v to water ℥ ss, will depress the action of the heart, and, as a consequence, prove beneficial. Dr. W. L. Roberts, uses three grains of tannic acid in one-third glass of water, giving as a dose two teaspoonfuls of this solution every five minutes until three doses are taken; then two teaspoonfuls every fifteen minutes if required. Rest, and the horizontal position, with the head and shoulders raised, are valuable adjuncts to the treatment. In some cases it may be found necessary to have recourse to the actual cautery. (See Gorgas's *Dental Medicine* for further details on alveolar hemorrhage.)

The late Professor Gross was the first to call attention to a form of neuralgia occurring after the extraction of teeth, and depending upon

thickening and induration of the alveolar margin, by which the remains of the dental nerves after the removal of teeth become compressed and irritated. The treatment in such cases consists in the removal of the margin of the alveolus compressing the nerve with cutting forceps, and thus freeing the irritated tissue.

CHAPTER VI.

THE USE OF ANESTHETIC AGENTS IN THE EXTRACTION OF TEETH.

Of the various agents that have been employed for the prevention of pain during surgical operations, sulphuric ether and chloroform have been more generally used than any others. The practicability of producing anesthesia with ether was first demonstrated by Dr. Horace Wells, of Hartford, Conn., in 1846, and soon afterward brought prominently before the medical and dental professions by Dr. W. G. S. Morton, of Boston, Mass., both practical dentists; and with chloroform, in 1847, by Prof. J. Y. Simpson, of Edinburgh, Scotland. The anesthetic effect is obtained by inhalation of the vapor, and is supposed to be nothing more than a transient state of intoxication, which usually disappears almost immediately after the discontinuance of the administration, though in many cases it has proved fatal. For this reason we do not think that agents capable of producing such powerful and dangerous effects as ether and chloroform should be used in so simple an operation as the extraction of a tooth. The first, however, is less dangerous than the second; but its anesthetic effect is less certain and prompt, from seven to ten minutes being usually required, whereas, with the other, it is obtained in from thirty seconds to two minutes. When ether is used, from six to ten or fifteen ounces are employed; but with chloroform it is rarely necessary to administer more than thirty to one hundred and fifty drops. What we have said about sulphuric ether applies equally to chloric ether, a substance very extensively used, if not first proposed, by the late Prof. Warren, of Boston.

A number of instruments have been devised for the inhalation of the vapor of these agents; but the simplest method of administration is from a hollow sponge, a napkin, or a pocket handkerchief.

It may not always be possible for any one, in the administration of either of the foregoing agents, even to a person supposed to be free from any special proclivity to disease from organic derangement, to pronounce, *à priori*, that no bad effect will result from it; but all agree

that it is unsafe to give it to a patient laboring under disease of the heart, brain, or lungs. The practitioner, therefore, whether medical or dental, should be well assured, before giving ether or chloroform, and especially the latter, that these organs are not only free from disease, but also from any morbid tendency, as ignorance with regard to this matter might lead to fatal consequences. It should be given cautiously under any circumstances, and the pulse should never be permitted to fall, during the inhalation, below sixty, or, at least, fifty-five beats a minute; but if, from carelessness or any other cause, the patient should sink and the pulsation cease, the agent should be immediately removed from the mouth, and if occupying a sitting posture he should be placed in a reclining position, air freely admitted, cold water dashed in the face, the feet and hands rubbed with hot salt or mustard, and, if necessary, artificial respiration made and galvanism applied. In addition to these means the tongue should be depressed and drawn forward by a finger thrust deeply into the mouth, as recommended by Ricord; or Marshall Hall's or Sylvester's or Howard's methods may be faithfully and patiently practiced. Ellis gives the following simplified formula of his method for cases of asphyxia from drowning: "Instantly place the patient on the face and side, supporting the head. Unfasten the clothes about the neck and chest, braces, etc. Wipe and clean the mouth and nostrils. Raise and support the chest on a folded coat or bundle. Roll the patient constantly and gently from the face to the side, and back again, occasionally changing the side, supporting the head. On the completion of each turn to the face make a brisk pressure on the back, between and below each shoulder blade. Dry and rub the patient briskly, rubbing upward."

The inversion of the body, a method devised by the celebrated French surgeon Nélaton, has been resorted to successfully. Nitrite of amyl, a powerful stimulant, has been successfully inhaled in cases of chloroform necrosis with dangerous symptoms, but care is necessary in its use; and not more than ♏ij should be administered by inhalation to persons unaccustomed to its effects.

It is thought by those who have had most experience in the use of ether and chloroform as anesthetic agents that their administration is attended with less danger when the patient is in a reclining than when in a sitting posture. It would be well, therefore, when ether is used preparatory to the extraction of teeth, to place the patient as nearly as possible in such a position; when the dentist is provided with an operating chair having a movable back, this can be very readily done.

Nitrous Oxid Gas is more generally employed as an anesthetic in the practice of dentistry than any other, and the immunity from accident with which it is administered is an evidence of its safety when

compared with chloroform and some other general anesthetics; due care, however, should be exercised in the use of all general anesthetics.

The anesthetic effect of nitrous oxid, or laughing gas, was first suggested by Sir Humphry Davy, in 1776, and practically demonstrated

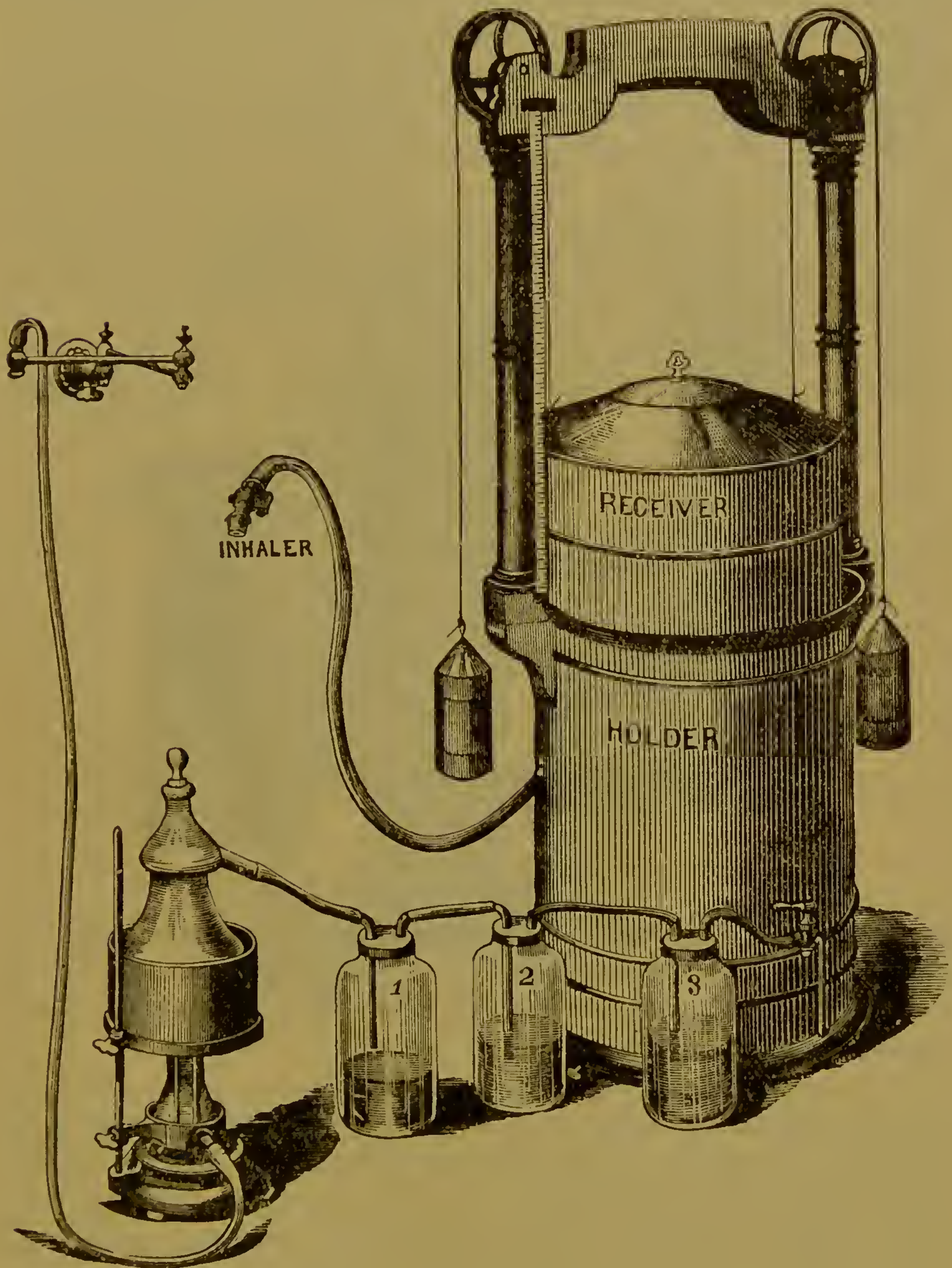


FIG. 577.

by Dr. Horace Wells. This gas is manufactured from the salt nitrate of ammonia, either in a fused or granulated form, by slowly melting and boiling it in a glass retort, over a sand bath, until nearly all of the nitrate is decomposed. The gas, on leaving the retort, passes through

several wash bottles, one of which contains either a solution of the sulphate of iron or caustic potash, and the other two pure water, for the purpose of purifying it before it enters a holder and receiver, from which it is administered to the patient by means of an inhaling tube. One pound of the granulated nitrate of ammonia will produce about thirty gallons of the gas, which should be administered to the patient in a pure state—unmixed with atmospheric air.

Fig. 577 represents an apparatus for generating nitrous oxid gas.

Liquefied Nitrous Oxid is, however, a more convenient form for use. To obtain this form the nitrous oxid gas, after being subjected to intense cold and pressure, is condensed in the form of a liquid, in a strong iron cylinder, one hundred gallons of the gas weighing but ten pounds, and capable of being condensed into a cylinder.

Fig. 580 represents the Justi gas cylinder holder for use in the operating room. To this cylinder holder the bag and inhaler, with metal

Fig. 578.

Fig. 579.

mouth shield, are attached. When it is desired to administer ether, the end tube, to which the rubber tubing is connected, can be unscrewed, and the globe, which contains a sponge to hold the ether, attached in its stead.

In administering this gas for dental operations, the patient is seated in an operating chair with a movable back, a cork or piece of wood to which a string is attached placed between the jaws, or, what is better, a soft rubber bite-block, of which four sizes are made, Fig. 578, which do not need a string, as they are readily removed with the crooked fingers, and are too large to be swallowed. Fig. 579 represents Daintree's adjustable mouth-prop.

The operator, who occupies a position on the right side of the patient, supports the inhaler with his right hand, some of the fingers of which press the lower lip tightly about the mouth-piece. The thumb and index finger of the left hand close the nostrils, while the

remaining fingers press the upper lip about the mouth-piece of the inhaler. The patient is then instructed to make long but otherwise natural inspirations, one of the valves of the inhaler permitting the exhalations to pass off.

After thus inhaling the gas for a few minutes, its anesthetic effects are shown by strong involuntary respirations attended by a snoring sound, owing to the relaxation of the muscles of the pharynx. Then follows a livid appearance of the lips, from the discolored blood in the capillaries. A spasmodic twitching of the muscles is observed at

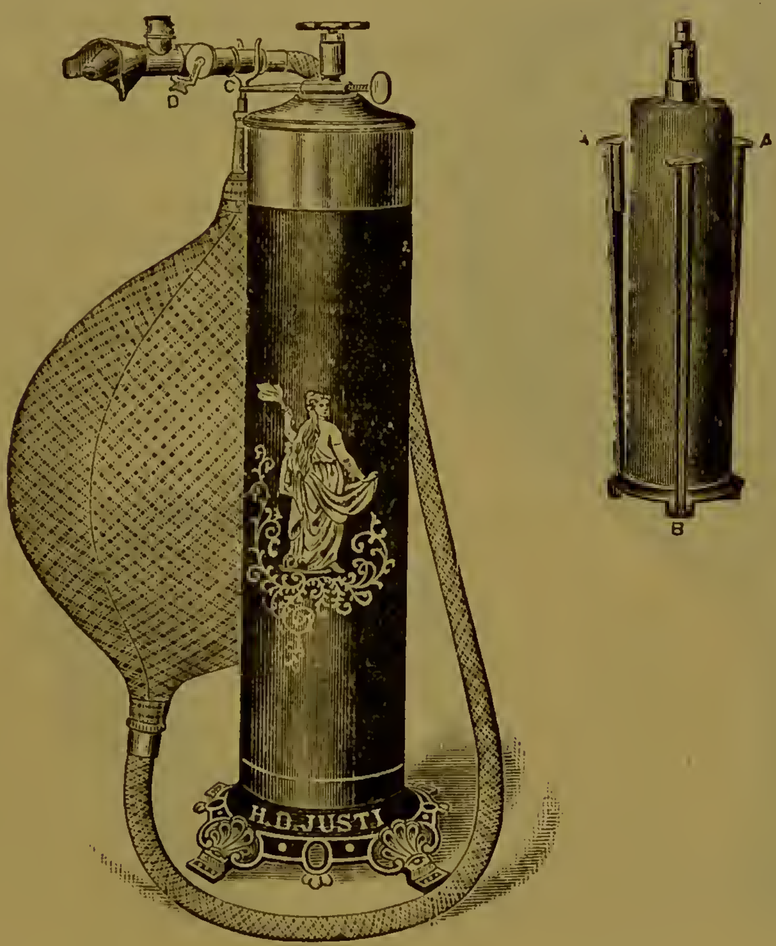


FIG. 580.

this stage in many patients, when complete narcosis follows. The narcotic effects of the gas continue from thirty seconds to one and a half minutes, and the number of teeth which can be extracted varies from four to twelve. It is no unusual occurrence, however, for the extraction of one tooth to consume the entire time the patient is under the narcotic influence of the gas, while in other cases more than the highest number just mentioned may be removed before the patient becomes conscious of pain.

Fig. 581 represents rubber inhaler hoods, which fit closely to the

face without unpleasant pressure, such as may be caused by the metal mouth-shield.

Nitrous oxid gas is considered to be the safest general anesthetic now in use, and does not produce the nauseating and debilitating effects which are often caused by ether and chloroform. Extreme caution, however, is necessary in administering this gas under circumstances which prohibit the use of other general anesthetic agents. The greatest objection to the use of this gas, aside from the question of safety, is the rapidity in operating which its transient effect necessitates; and it is much better to carefully extract a few teeth than to attempt the removal of many by an operation which may be attended with severe laceration of the gums and fracture of the alveolus.

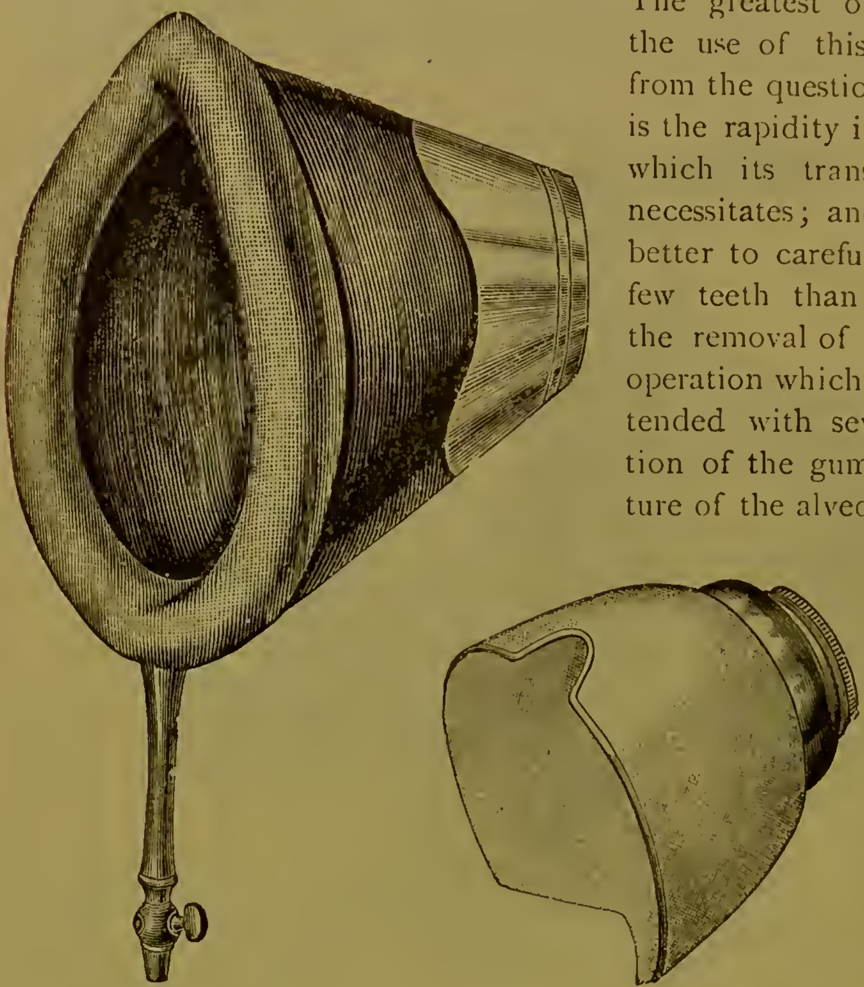


Fig. 581.

Bromid of Ethyl.—Hydrobromic ether is obtained from bromid of potassium and sulphuric ether, by distillation, and by redistillation with chlorid of lime. Although a pleasant anesthetic and very prompt in its effect, yet its administration is not without danger, and hence caution is necessary in its employment. It is administered in the same manner as ether or chloroform, and recovery from its influence is more rapid than with either of these agents. From thirty seconds to five minutes are required to manifest its anesthetic effects. The quantity required differs, according to the susceptibility of the patient,

the usual rule being to commence with one dram, then administer a second, and if necessary a third dram may be inhaled in two minutes after the administration of the second dram. Two drams will, however, in most cases, be sufficient to cause profound anesthesia.

Dr. B. W. Richardson, of London, introduced an anesthetic agent, known as the *bichlorid of methylene*, which is formed by the action of sulphuric acid on zinc in chloroform. It differs, however, from chloroform, in the circumstance that one atom of chlorin is replaced by one atom of hydrogen. Bichlorid of methylene produces as great a degree of insensibility as chloroform, and its action is more rapid and the narcotism very prolonged. It also interferes less with muscular irritability than either ether or chloroform, and the recovery from its effects is sudden; but more of it is required. When it destroys life, as it has in several cases, the respiring and circulating functions are equally paralyzed.

Hydrate of chloral is another general anesthetic agent which has been extensively employed. Chloral is by no means a new anesthetic, Liebig having discovered it in 1830; but, as Dr. B. W. Richardson states, the introduction of it into medicine is a fact of the year 1871, its introducer being Liebreich, of Berlin.

The hydrate is made from the chloral by the simple addition of a little water, and on the application of heat solidifies into a white crystalline substance.

The manner in which hydrate of chloral is administered is in solution with water, either by the mouth directly into the stomach, or by subcutaneous injection. The best solution is made by mixing one grain of the hydrate with two of water. Dissolved in an excess of water, the taste is agreeable, with the odor of a ripe melon. It is administered to human subjects in doses varying from 25 to 30 grains, causing unconsciousness to pain and a profound sleep lasting over several hours. The sleep is gentle and quiet, induced without distress, and leaving no other symptom behind except nausea, which is occasionally experienced after recovery. In administering this agent, it appears to act more promptly when subcutaneously injected than when administered directly by the mouth; and as chloral dissolved in water is slightly caustic, it cannot be administered by the mouth when there are lesions of mucous membrane or ulcerated tracts of intestinal canal. In administering hydrate of chloral to the human subject, Dr. Richardson states that allowance will have to be made not only in relation to size and weight, but to obesity or leanness, to natural habit and actual state of body in respect to sensibility.

Fig. 582 represents the full size of a hypodermic syringe with graduated rod and steel points.

Local Anesthetics.—Suspension of nervous sensibility induced by inhaling the vapor of ether, chloroform, nitrous oxid, bromid of ethyl, etc., is general, every part of the body being affected alike; but partial or local anesthesia may be procured by other and less dangerous means. Congelation or freezing, first proposed and employed in the Charity Hospital, Paris, by an *interne* of M. Velpeau, and subsequently recommended by Dr. James Arnott, of London, was formerly resorted to both by surgeons and dentists, and practiced to a limited extent with success. This may be effected by applying a mixture of pounded ice and common salt, in the proportion of two or three parts of the former to one of the latter, to the part on which the operation is to be performed. But in the use of this care is necessary to prevent reducing the temperature too much, as in this case loss of vitality would be occasioned by it. We have heard of a few cases in which this has occurred, but we believe it was owing in every instance

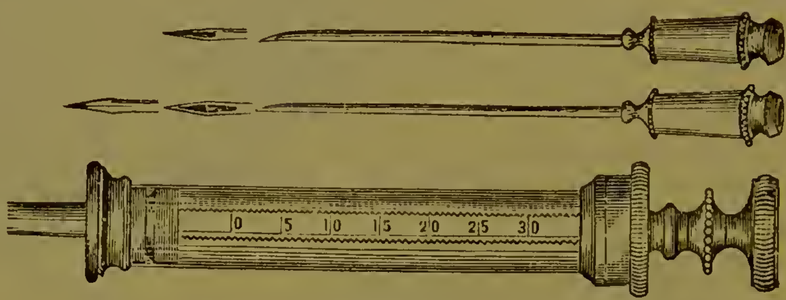


FIG. 582.

to carelessness or want of judgment on the part of the operator as to the length of time the application of the mixture should be continued.

Several instruments have been invented for the application of this freezing mixture to teeth preparatory to extraction. One of the first adapted for the purpose was designed by Dr. Branch, of Chicago, Ill. It consisted of a hollow tube about an inch or a little more in diameter, with about five-eighths of an inch cut out at one end, on either side, that it might readily be passed over a tooth. To this was attached a sac of finely prepared membrane, large enough to hold a tablespoonful of the mixture. The hollow of the tube was occupied by a steel wire spiral spring. Just before using it a sufficient quantity of the freezing mixture was put in the tube; the end of the latter was placed over the tooth, when the ice and salt were forced up gently around it by pressing on the spring at the other extremity of the instrument. Two tubes were employed, one straight, for teeth in the anterior part of the mouth, the other bent near one end for the more convenient application of the mixture to a molar tooth.

The sudden application of such intense cold to a sensitive tooth, or

to one which has not lost its vitality, is often productive at first of severe pain; on this account many objected to its use, preferring the momentary suffering consequent upon the operation of extraction rather than that occasioned by the freezing mixture. But this effect is rarely experienced in its use on dead teeth, or the roots of teeth which have lost their vitality; hence, the application of it to such teeth proved more satisfactory than to living teeth.

In the year 1858 Mr. J. B. Francis, dentist, of Philadelphia, announced the discovery of an original method of producing local anesthesia, said to be peculiarly applicable to the extraction of teeth, which consists in passing an electro-galvanic current through the tooth at the moment of its removal. The discovery was submitted to the Franklin Institute, Philadelphia, and the committee to whom it was referred for examination, composed in part of dentists, reported favorably in regard to the claims of the inventor. One of the members of the committee, W. S. Wilkinson, stated that he had extracted between four and five hundred teeth, applying the electric current, and that in ninety-five per cent. of the cases it was done without pain to his patients.

The method of applying it is very simple. One pole (the negative is preferable) of the electro-galvanic machine is attached to one of the handles of the forceps by means of a flexible conductor, while the metallic handle of the other is grasped by the patient, the power of the current being, previously to the operation, graduated by the piston of the coil, while the patient holds the forceps in the other hand. The current should only be sufficiently powerful to be distinctly felt. The circuit through the tooth is not made until at the instant the operation begins. The closing and breaking of the galvanic circuit is managed either by the foot of the operator or by an assistant.

A small electro-galvanic battery, arranged for this purpose, having been placed in the office of the author soon after the announcement of the discovery, he has had frequent opportunities of applying this new agent in the extraction of teeth. Thus far, about nine out of ten of those who were placed under its influence while undergoing the operation assured him that they either experienced no pain at all or only very little—not a tenth part of what they had experienced under the operation on former occasions. In almost every case in which the tooth was grasped, allowing the instrument to come in contact with only the edge of the gum, the operation appeared to be painless, or nearly so. But when pushed up a considerable distance between it and the tooth the suffering was not appreciably diminished, the electric current in such cases seeming to be too much diffused. It is stated by those who have made the experiment that this diffusion of the electric

current may be prevented by insulating the outer portion of the instrument with a coating of gutta-percha, or by japanning. The author has not tried this expedient.

How it is that the passage of an electric current through a tooth should prevent pain may be explained by supposing the subtle fluid to exhaust the sensibility of the nerves of the parts comprised in the operation; and that it does, in a majority of cases, is attested by many who have been placed under its influence. It may be nothing more than a mere substitution of one sensation for another; but whether its application will become general, or its efficacy as an anesthetic agent be fully established, remains for future experience to settle.

The experience of the profession may be briefly summed up thus: In one-fourth the cases it relieves or neutralizes the peculiar pain of extraction, in one-half it has but little effect, and in the remaining fourth it very decidedly aggravates the pain. It has, however, the advantage over chloroform and the freezing process of being without any serious sequelæ.

"Voltaic narcotism" is a term applied by Dr. B. W. Richardson to a method of local anesthesia, in which the galvanic current is passed through a narcotic solution placed in contact with the part to be operated upon. Dr. Richardson claims that by such a method complete local anesthesia can be produced by solutions of narcotic agents which are inert when applied without the galvanic current. While this method may be used with satisfactory results in cases where the cavity of the tooth is exposed, it has never come into general use.

Dr. B. W. Richardson also introduced a much more speedy and effectual method of congelation than those before described, by taking advantage of the intense cold occasioned by the rapid evaporation of ether spray when forced through one of the instruments invented for the atomization of fluids.

"The principle," Dr. Richardson remarks, "consists in directing on a part of the body a volatile liquid, having a boiling point at or below blood heat, in a state of fine subdivision or spray, such subdivision being produced by the action of air or other gaseous substance on the volatile liquid to be dispersed. When the volatile fluid, dispersed in the form of spray, falls on the human body, it comes with force into the most minute contact with the surface upon which it strikes. As a result there is rapid evaporation of the volatile fluid, and so great an evolution of heat force from the surface of the body struck, that the blood cannot supply the equivalent loss. The part, consequently, dies for the moment, and is insensible, as in death; but as the *vis a tergo* of the body is unaffected, the blood, as soon as the external reducing agency is withdrawn, quickly makes its way again through

the dead parts, and restoration is immediate. The extreme rapidity of the action of this deadening process is the cause of its safety."

Fig. 583 represents the apparatus, which consists of a spray-tube, bottle, and hand-bellows, for producing local anesthesia by narcotic spray.

Either absolute ether or rhigolene may be employed, both of which are highly inflammable. Some prefer rhigolene on account of its action being more prompt than that of the ether, while others consider the latter more agreeable and easily controlled. To produce the local anesthetic effect with these agents in the form of spray requires from thirty to sixty seconds. Before the application of the spray the crown of the tooth to be extracted and mucous membrane over the root should be carefully dried, otherwise a film of ice may be formed which

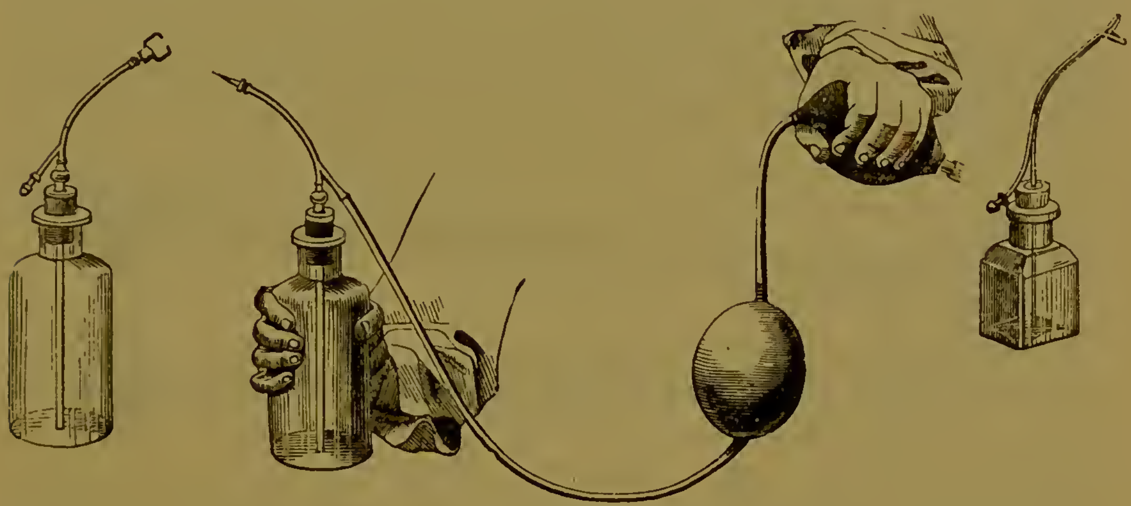


FIG. 583.

will prevent the full influence of the agent, such as is shown by the blanching of the gum.

Local blood-letting, such as follows lancing of the gums, prior to the application of the spray is said to prevent desquamation.

Obtunding mixtures, consisting of a combination of pyrethrum, aconite, chloral, veratria, and alcohol; or chloroform, aconite, belladonna, and opium, have been employed to produce local anesthesia, and in many cases with satisfactory results. For although entire insensibility to pain cannot in all cases be brought about, yet some diminution of it may be effected by the use of such agents. They have the merit, at least, of being less dangerous than the general anesthetics. Such pain-obtunding mixtures are best applied to the parts about the neck and over the root of a tooth by means of a simple apparatus devised by Von Bonhorst. It consists of two small metallic cups attached to the free ends of a spring some seven inches long, and which contain sponges to hold the liquid (Fig. 584).

When used, the sponges in the cup are saturated with the obtunding mixture and applied by pressing them on the gum on each side of the tooth to be removed, where they are retained from one-half to two minutes. Previous to the application the patient should be cautioned against swallowing any portion of the mixture.

A local anesthetic known as cocain was discovered and first applied in Germany, with astonishing and satisfactory results, in operations upon the eye. This local anesthetic has been employed with more or less satisfactory results in cases of sensitive dentine and the extirpation of the pulps of teeth by the surgical method, with satisfactory results in teeth of a loose structure. The four or five per cent. solution of hydrochlorate of cocain, may be used, a drop being applied to the sensitive surface three times, at intervals, during a period of ten or fifteen minutes; at the end of twenty-five minutes a condition of anesthesia is caused.

The unsatisfactory results from the use of cocain as a local anesthetic for the extraction of teeth, owing to the dense and impermeable character of the gum-tissues, when the agent is applied directly to the

FIG. 584.

mucous membrane, led to its application by injection with the hypodermic syringe, represented by Fig. 582, either deeply into the gum-tissues, or to a point as near as possible to the main branches of nerves supplying the teeth with sensation. For injecting the cocain deeply into the gum-tissues, the syringe, which should be an easy-working instrument, is charged with from 12 to 15 minims of a four or five per cent. solution, and the needle-point introduced through the mucous membrane, so as to inject the solution deeply into the gum-tissues around the tooth to be extracted. To reach the branches of nerves supplying the superior teeth it has been suggested to pass the needle-point of the syringe through the mucous membrane to a point as close to the infraorbital foramen as is possible, and inject about eight minims of the cocain solution; for reaching the inferior dental nerve, the needle-point is carried as near the inferior dental foramen as is possible, or, in the case of the front teeth, near to the mental foramen. Dr. Raymond recommends mixing the soluble alkaloid at the time of using it, taking care to exhaust the air from the syringe when charged ready for use, which may be done by drawing in more of the solution than

is needed, and pressing it out to the required number of minims (about eight), and then to hold the needle-point up so as to allow the air to get above the solution, when the piston should be pressed.

"The Herbst Obtundent" consists of a saturated solution of hydrochlorate of cocain in chemically pure sulphuric acid, to which a solution of sulphuric ether is added to the point of saturation, the excess of ether evaporating from the surface on which it floats. About 70 grains of the cocain hydrochlorate are required to saturate two drams of the sulphuric acid. Several applications are required to produce the anesthetic effect.

Cocain is the alkaloid of the leaves of the *Erythroxylon coca*, a shrub of South America, and has long been used by the natives of Peru and Bolivia as a nerve-stimulant. Small animals have been killed by its causing paralysis of the respiratory centers.

Other local anesthetics have recently been suggested, such as tropacocain, coryl, chlorid of ethyl, etc. (See Gorgas's *Dental Medicine*.)

Rapid Breathing as a Pain Obtunder.—The possibility of producing an anesthetic effect by rapid breathing was suggested by Dr. W. G. A. Bonwill, in 1875. By this method it is claimed that teeth may be extracted without pain. In applying it the patient should rest upon the side and in as reclining a position as is possible to operate. A handkerchief is then placed over the face to insure quiet, and directions are given to breathe rapidly at the rate of about 100 respirations per minute—blowing-out movement. At the end of from two to five minutes of such rapid breathing it is claimed that an entire, or at least partial, state of anesthesia results, which may continue for a half or for one or two minutes. This method is apparently a harmless one, but some have connected with it such a danger as venous congestion of the brain. Females appear to be more susceptible to this method than males, and children under ten years of age can rarely be induced to breathe properly.

In the case of females with a highly nervous organization it may now and then be advisable to give a temporary courage to endure pain by the administration of a teaspoonful of brandy. But there is often less trouble with delicate females than with stalwart men. The extraction of a tooth is, in the majority of cases, so simple an operation, seldom requiring more than from two to five seconds for its performance, that most persons should rather submit to it at once than have it protracted by the application of an agent for the prevention of the momentary pain which it occasions.

CHAPTER VII.

REPLANTATION, TRANSPLANTATION, AND IMPLANTATION OF TEETH.

Closely connected with the subject of extraction of teeth are Replantation and Transplantation, which appear to have been practiced several centuries ago, both in France and Germany.

Later, both of these operations attracted the attention of John Hunter, in England, and some interesting experiments were made by him in transplanting teeth, although he did not advocate the latter practice.

The operation of "replantation" consists in the return of a tooth to the same cavity from which it has been extracted, and also the necessary antiphlogistic treatment which will result in the re-establishment of the connection which originally existed between the tooth so returned and its cavity. Replantation is performed where a tooth has been accidentally removed, and also for the cure of alveolar abscess, more especially such cases where the extreme end of the root is affected with abscess, and a considerable portion of the investing membrane or periosteum is in a healthy condition. Under such circumstances the operation of replantation may be performed as follows: The tooth is to be very carefully extracted, and at once placed in warm water, to which a little tincture of iodin has been added. The cavity from which the tooth has been removed should be carefully and gently wiped out with a cone of soft Japanese paper, wrapped about the end of an excavator or other suitable instrument, to remove any shreds of the abscess sac that may remain attached to its walls, and a delicate, spear-shaped nerve instrument passed through the alveolus to detach the cyst. The cavity is then syringed with warm water and packed lightly with cotton saturated with tincture of iodin.

When this is accomplished, attention is again given to the tooth, from which all traces of the abscess sac should be removed, as well as salivary calculus, if present, care being taken, however, not to injure or remove any healthy periosteum that may remain attached to the root. The pulp chamber is then to be exposed, and, with the root canals, thoroughly cleansed and disinfected, and filled to the apex with gold or other suitable material. The packing is then carefully removed from the cavity, which is again syringed with warm water, and the tooth firmly pressed into its former position and held there for a few moments with the fingers. The mouth may then be rinsed with an astringent mouth wash and the tooth secured by ligatures, or,

with what answers better, a cap of modeling composition or gutta-percha. The mouth should be rinsed with an astringent wash three or four times daily, and be kept thoroughly clean.

The following mouth washes, from Gorgas's *Dental Medicine*, will prove useful:—

℞. Acidi carbolici (cryst.),			
Glycerini and aquæ rosæ, ... āā	ʒ ij.		M.

Sig.—Five to eight or ten drops in a wineglass of water.

℞. Tincturæ arnicæ, ...	ʒ ij	
Glycerini, ...	ʒ ij	
Aquæ rosæ, ...	℥ ij	
Aquæ destillatæ, ...	℥ x.	M.

Sig.—To be used as a gargle.

Where the apex of the root of the tooth is necrosed, this portion should be excised and made smooth before the tooth is returned to its cavity, the same treatment as above described being pursued. When a replanted tooth has been returned to its cavity, the lymph present either coagulates and becomes organized, so that no pus is formed, which is the process of healing by "first intention," or the lymph may degenerate into pus, in which latter case the operation may prove a failure. To obviate such a condition, it has been suggested to make an opening through the alveolus to the apex of the root of the tooth, and, by means of floss silk or a pledget of cotton, to establish a drainage, or to insert a drain tube from the surface of the crown through the canal to the apex of the root.

The operation of "transplantation" consists in the extraction of a tooth from the mouth of one person and transferring it to a cavity in the mouth of another; in some cases the teeth of animals have been substituted for human teeth.

The defective tooth is first extracted, and having previously selected a tooth in the mouth of another, which will correspond in size, color, location, and other characteristics, it is carefully extracted and immediately transferred to the cavity from which the defective tooth has been removed, as soon as the hemorrhage has ceased. When the tooth to be transplanted is of a different form from the one it is to replace, it must be made to correspond to the new cavity by properly changing its dimensions, a procedure that would not be possible, to the same degree at least, in the case of replantation, for many examples are presented of dried teeth having been successfully transplanted. The operation of transplantation is completed by securing the new tooth in position and employing the necessary antiphlogistic treatment, as in replantation. Such teeth, however, never perfectly

harmonize with their new relation, and when a dried tooth is used its pulp canal should be previously filled with gold. It is also suggested to excise a portion of the end of the tooth, from one-sixteenth to one eighth of an inch, and to separate, by a non-conducting substance, the root filling from that in the crown, and, as in the case of replantation, to prescribe an unstimulating diet. In the operation of replantation we depend for success upon a reattachment of the peridental membrane; but in the case of transplantation, and especially where dried teeth are made use of, stability is due to absorption of the dead tissue, on the one hand, and a corresponding hypertrophy of living tissue, on the other, the root of the tooth undergoing loss of structure in the form of small cavities, and the wall of the alveolar cavity thickened by ossific deposit at points corresponding to the cavities formed in the dead tissue of the root. And while it may require one week for a replanted tooth to become firm, two or more may be necessary in the case of a transplanted tooth. For retaining replanted and transplanted teeth in position, either the modeling composition and gutta-percha splints before alluded to may be employed, or the ingenious device of Dr. Herbst, which is represented by Fig. 246 (p. 384). An interdental splint of either modeling composition or red gutta-percha, pressed while soft over the newly-placed tooth, and the teeth of both jaws brought in contact and pressed slightly into the plastic mass, will also prove effectual as a retaining appliance.

While the operation of "replantation" is a justifiable one, that of "transplantation" is objectionable for several reasons, namely: the necrosed condition of such a tooth, and, as a consequence, its uncertain duration; the liability to failure; the liability of inoculation by the transmission of disease; and the inhumanity of inflicting loss and pain on one person in order to give another a very uncertain advantage.

An operation known as "implantation" has recently been advocated by Dr. W. J. Younger. It consists in drilling artificial sockets in the maxillary bones, and inserting therein natural teeth of the proper size, shape, and shade, or at least so nearly resembling the shade of the adjoining teeth as devitalized teeth can present. Dr. Younger's method is to carefully dissect from the bone the overlying soft tissues, such as the gum and periosteum, in such a manner as to retain their connection in the form of a continuous flap, so that it may be replaced about the neck of the implanted tooth and assist in securing it. Graded trephines and burs, operated by the dental engine, are then applied to the maxillary bone, a socket drilled of the size and shape of the tooth to be implanted, which is selected prior to commencing the operation of dissecting the soft tissues.

If the tooth is a recently extracted one (although it is claimed that teeth which have been extracted months previously can be implanted), the pulp is removed and the canal filled with gold at its apex and with gutta-percha in the remaining portion. The tooth is then subjected to a solution of bichlorid of mercury, two parts to 1000 of water, at the temperature of 110° F. for some fifteen minutes. The instruments employed in the operation are immersed in the bichlorid solution, and also the root of the tooth. The artificial socket, which has been prepared in the manner above described, is then carefully cleansed with the same solution, cold water being employed to arrest the hemorrhage, and the tooth placed in position and secured by means of ligatures. The theory upon which Dr. Younger's method is based is that the natural alveolar cavity has no periosteum, and that the formation of these cavities depends upon the thin and delicate membrane lining the cells and interspaces of the osseous structure. He regards the peridental membrane as possessing no "callus generative energy except from its dental aspect;" the other side, he asserts, has the power only of forming attachment. He also claims that the vitality of the peridental membrane is kept up for many months after the extraction of the tooth, and cites examples of teeth having been successfully implanted after they had been extracted for more than a year. The failures attending the operations of replantation and transplantation he ascribes to the existence of disease at the time of treatment, a condition that does not exist when a healthy root is implanted into an artificially formed cavity in the bone.

The records of the cases of implantation, however, do not show that this operation has been to any degree more successful than those of replantation and transplantation; and the failures only prove that physiological law cannot be violated with impunity, as there are certain factors which must not be ignored. The operation of implantation is a most interesting one, as it is novel and unique, and aside from the pain experienced by the patient, one of its greatest dangers is the inoculation of disease; and this objection can also be urged against transplantation with equal force.

Figs. 585, 586, 587, and 588, represent implantation instruments for Dr. Younger's operation.

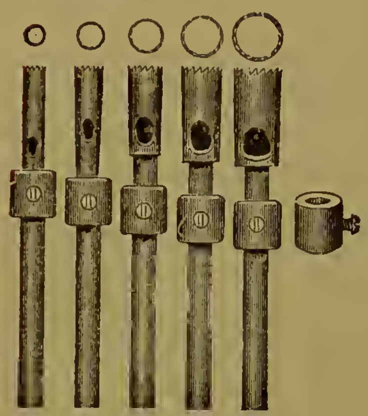
The hole in the jaw bored to that depth by the trephine is then enlarged by the reamers to fit the root which is to be implanted.

Tubular Knife No. 3 is a medium size, with which the soft tissues are cut to the bone. For the incisors and cuspids, the hole this makes corresponds fairly with the shape of the tooth at the neck. For the bicuspids, which have a more or less oblong shape on cross-section, this round hole would, apparently, not be of the correct

shape. It is only necessary, however, to have a tubular knife which measures a little less in circumference than the tooth at its neck to insure a perfect fit, for the soft tissues are elastic enough to conform to the tooth if the hole is large enough.

Spiral Knife No. 1 has two blades. In use it

TREPHINES.



1 2 3 4 5

FIG. 585.

REAMERS.

1 2 3

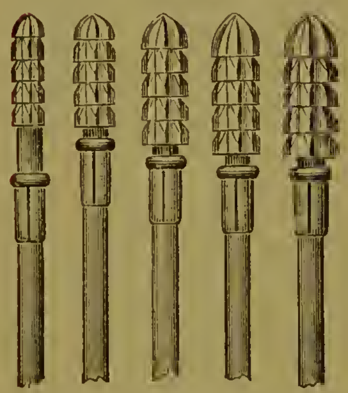
FIG. 586.

SPIRAL KNIVES. TUBULAR KNIVES.

1 2 3

FIG. 587.

OTTOLENGUI IMPLANTATION REAMERS.



1 2 3 4 5

FIG. 588.

is pressed against the bone and pushed in to the shoulder, which should be adjusted to the proper position. This instrument cuts the bone with great rapidity and without any special pain.

No. 2 is a similar knife, only more conical. This is pressed into the hole previously made, and then swayed to enlarge the cavity to fit the root. It will be necessary to use this but twice, as the eye carries the shape of the root with enough accuracy to enable one to get the hole of almost the right shape the first time.

CHAPTER VIII.

DISLOCATION AND FRACTURE OF THE JAW.

FROM the peculiar manner in which the inferior maxilla is articulated to the temporal bones, it is not very liable to dislocation. When it occurs in one or both of the condyles, the luxation is always forward, the conformation of the parts preventing it from taking place in any

other direction. The oblong, rounded head of each condyle is received into the forepart of a deep fossa in the temporal bone, situated just before the meatus auditorius externus, and under the beginning of the zygomatic arch. The articular surface of each is covered with a smooth cartilage, and between them there is a movable cartilage. This latter is connected with the articulating surfaces of the condyle and glenoid cavity, externally by the external lateral ligament, internally by the capsular ligament, and in front by the tendon of the external pterygoid. This cartilage is sometimes called the meniscus, from its shape, being thickest around its circumference, especially at the back part. The temporo-maxillary articulation is strengthened by an internal, an external, and a capsular ligament, also by the tendinous and muscular insertions of the masseter, temporal, and pterygoid muscles. The intervening movable cartilage, being more closely connected with the head of the condyle than with the glenoid cavity, escapes with the former whenever dislocation of the jaw takes place.

Dislocation of the lower jaw is rarely caused by a blow, unless given when the mouth is open ; it is more frequently occasioned by yawning or laughing. It has been known to occur in the extraction of teeth, and in attempting to bite a very large substance. Sir Astley Cooper mentions the case of a boy who had his jaw dislocated by suddenly putting an apple into his mouth to keep it from a playfellow.

After the jaw has been dislocated once, it is always more liable to this accident; consequently, Mr. Fox very properly recommends to those with whom it has once happened the precaution of supporting the jaw whenever the mouth is opened very widely in gaping or for the purpose of having a tooth extracted. None of these causes would be sufficient to produce the accident, unless the ligaments of the temporo-maxillary articulation are very loose and the muscles of the jaw much relaxed.

The author witnessed a case of dislocation of the lower jaw in which the displacement occurred during an attempt to extract the first right inferior molar. The patient was a young lady from Virginia, about seventeen years of age. Both condyles were luxated, but so completely were the muscles of the jaw relaxed that he immediately reduced it without the least difficulty, and afterward, by supporting the jaw with his left hand, succeeded in removing the tooth.

When the lower jaw is dislocated the mouth remains wide open, as seen in Fig. 589, and a great deal of pain is experienced ; this, according to Boyer, is caused by the pressure of the condyles on the deep-seated temporal nerves and those which go to the masseter muscles, situated at the root of the zygomatic process. The condyles, having left their place of articulation, are advanced before the articular

eminences and lodged under the zygomatic arches. The jaw cannot be closed; the coronoid processes may be felt under the malar bones; the temporal, masseter, and buccinator muscles are extended; the articular cavities being empty, a hollow may be felt there; the saliva flows uninterruptedly from the mouth, and deglutition and speech are either wholly prevented or very greatly impaired. Boyer says that during the first five days after the accident the patient can neither speak nor swallow. The jaw, when only one condyle is displaced, is forced more or less to one side.

FIG. 589.

If the dislocation continues for several days or weeks, the chin gradually approaches the upper jaw, and the patient slowly recovers the functions of speech and deglutition. We are told by Mr. Samuel Cooper that it may prove fatal if it remains unreduced;* but Sir Astley Cooper says he has never known any dangerous effects to result from this accident; on the contrary, after it has continued for a considerable length of time the jaw partially recovers its motion.†

In the reduction of dislocation of the lower jaw the older surgeons employed two pieces of wood, which were introduced on each side of the mouth, between the molar teeth; while these were made to act as levers for depressing the back part of the bone, the chin was raised by means of a bandage.

The method usually adopted by modern surgeons for reducing a dislocation of this bone consists in introducing the thumbs, wrapped in a napkin or cloth (to prevent them from being hurt by the teeth), as far back upon the molars as possible; then depressing the back part of the jaw and at the same time raising the chin with the fingers. In this way the condyles are disengaged from under the zygomatic arches and made to glide back into their articular cavities. But the moment the condyles are disengaged the thumbs of the operator should be slipped outward between the teeth and the cheeks, as the action of the muscles at this instant, in drawing the jaw back, causes it to close very suddenly and with considerable force. This precaution is necessary to avoid being hurt, unless a piece of cork or soft wood has been previously placed between the teeth.

* "Surgical Dictionary," p. 306. † A. Cooper on "Dislocations," p. 389.

By the foregoing simple method the dislocation may, in almost every case, be readily reduced; but Mr. Fox mentions a case in which it failed. The subject was a lady whose lower jaw had been luxated several times before; this time the accident was occasioned by an attempt which he made to extract one of the inferior dentes sapientiæ. After having failed to reduce the luxated bone by the usual method, he "happened to recollect a statement made to him by M. de Chemant, who, having been frequently applied to by a person in Paris who was subject to this accident, had always succeeded in immediately reducing the luxation by means of a lever of wood, as recommended by Dr. Monroe." Profiting by this statement, Mr. Fox procured a piece of wood about an inch square and ten or twelve inches long. He placed one end of this upon the lower molars, and then raised the other, so that the upper teeth acted as a fulcrum. As soon as the jaw was depressed the condyle of the side upon which the wood was applied immediately slipped back into its articular cavity. The wood was then applied to the opposite side of the jaw, and the other condyle reduced in the same manner.*

The method practiced by Sir Astley Cooper consists, when both condyles are displaced, in introducing two corks behind the molars and then elevating the chin. He, however, first places his patient in a recumbent posture; † but this is seldom necessary. The reduction of the dislocation can be as conveniently effected with the patient in a sitting as in a recumbent posture.

After the reduction of the dislocation the patient is recommended to abstain for several days from the use of solid aliments and to wear a four-tailed bandage; ‡ or, what is still better, the bandage contrived by Mr. Fox (Fig. 271, p. 395), to prevent its recurrence in the extraction of teeth. When this bandage is used for the latter purpose the mouth is first opened to the proper extent, with the condyles in their articular cavities; it is then applied and the straps tightly buckled. This done, it is impossible to advance the jaw sufficiently to produce a dislocation.

FRACTURES OF THE JAWS.

Fractures of the jaws rarely occur except from direct violence. In the upper jaw this violence is usually of a character that complicates the fracture with severe injury to adjacent parts. Gunshot wounds are by far the most frequent source of fractures in this

* American edition of Fox on "The Human Teeth," p. 330.

† A. Cooper on "Dislocations," p. 391.

‡ Cooper's "Surgical Dictionary," p. 306.

locality; and it is wonderful what an amount of injury to the bones of the face may be recovered from without ill result. The bones of the face are of softer character than those found elsewhere, and consequently the whole injury is at the place of impact and along the course of the ball; no long fractures or extensive contusions are found, or very rarely so, and the parts are abundantly supplied with blood, hence the restorative process proceeds very rapidly; but this abundant sanguineous supply, so useful in the restoration of parts, is also the chief source of danger. Hemorrhage is generally excessive and difficult to control, and to secondary hemorrhage is due the greatest fatality in injuries of this kind, ligature of the carotid artery, which has been frequently practiced, usually serving but to postpone the fatal termination. Owing to the liberal supply of blood, necrosis seldom occurs, and it is seldom necessary to remove fragments of bone, even after the most extensive comminution; they should be left, except for some peculiar reason, until death is manifest in them, when they may be abstracted without additional trouble. Loosened teeth should always be left to contract adhesions, which they will generally readily do. Indeed, but little surgical interference is required in cases of this kind, and should usually be limited to efforts to secure the proper apposition of the teeth. Numerous cases of the most extraordinary injuries to the face are to be found in the surgical reports of the late war in the States, and in those of the French and English surgeons during the wars of the first Napoleon and the Crimea. Fractures of the superior maxilla may, however, occur from other violence than gunshot wounds. Mr. Salter reports a case resulting from the collision of the face and head of two "cricketers." The kick of a horse, as in the well-known Wiseman case, has occasioned frightful injury of this character. In this case the "face was driven in, the lower jaw projecting forward. . . . . The bones of the palate were driven so far back it was impossible to pass my finger behind them." The patient made a good recovery. Mr. Heath records a case reported by Dr. Tyffe, in which, "on watching the patient's profile while in the act of swallowing food, the whole of the bones of the face were observed to move up and down upon the fixed part of the skull as the different parts were brought into motion. It appeared as if the integuments only retained them in their position. It was a curious feature in the case that, notwithstanding the very extensive injury done and the violent character of the force which caused it (the upsetting of a cab), not a single tooth was fractured or misplaced. Fractures in the dentist's chair, from ill-directed efforts to remove teeth, not uncommon when "keys" were in general use, are now so infrequent as to be undeserving of special mention.

Among the complications of fracture of the upper jaw may be mentioned breaking and displacement of teeth, closure of the nasal duct with consequent epiphora, secondary hemorrhage, and paralysis of the infra-orbital nerve as the most common.

Diagnosis of fractures of the upper jaw is usually attended with but little difficulty. It is determined by pain, crepitation, irregularity in the line of the teeth, and excessive secretion of saliva. The treatment consists in the nice adaptation of the teeth and their permanent security in proper position. This is generally effected with but little difficulty, by a single finger passed into the mouth to press the fragments into position, where they may be secured by wires, or, in cases of great displacement, by the interdental splint. The hemorrhage should be controlled by styptics, of which the persulphate of iron is the best, by the actual cautery, and, when not otherwise manageable, by ligation of the carotid artery.

Fractures of the lower jaw are much more common than those of the upper. They give comparatively little trouble, are readily diagnosed, and are occasioned by direct violence, as in the upper jaw. The most common seat of fracture is the middle of the horizontal ramus. Before the use of interdental splints, fractures of the lower jaw were difficult of adjustment and were frequently attended with bad results, and in rare cases they still are so. A good many forms of apparatus have been devised, of which the simplest is the four-tailed bandage, which consists of a slip of muslin, of suitable dimensions, torn from each extremity toward the center, leaving enough space to receive the chin. It is secured by passing the tails over the top of the head and around the back of the neck, and tying them in this position. This apparatus may be supplemented by a pasteboard splint molded to the form of the jaw. Sometimes the bones are secured in position by passing wires around the firm teeth and binding them together. They may also be secured by sutures, the bones having been drilled to permit their passage. Mr. Wheelhouse, of Leeds, recommends that, after drilling through the bones on either side of the fracture, silver pins, "with flat, circular, and perforated heads," be passed through the opening from within outward, and their points bent in opposite directions so as to form hooks, and the fragments secured by passing silver or gold wire in a figure-of-eight over the pins. The perforations in the head of the wires are for silk sutures, by which they may be readily removed when necessary. It is also recommended that not only should the fragments be secured together in this way, but that they also be bound to the upper jaw. Wedges of cork cut into suitable shapes; of gutta-percha, introduced and molded to the teeth; Mutter's silver clamps, or their modification by Mr. Tomes; Hayward's silver

caps, and other more complicated apparatuses may, in our judgment, be all superseded by the vulcanite interdental splint contrived about the same time and independently of each other by the late Dr. Bean, of Baltimore, Md., and Dr. Gunning, of New York, except in cases of obstinate vertical displacement. An impression in wax is first taken of both jaws, from which a plaster cast is taken, and upon this the vulcanite plate is accurately molded with indentations corresponding exactly to the adjusted teeth, and with an interspace at the most convenient point for administering food. The splints are now introduced into the mouth, the teeth arranged in their appropriate indentations, and the whole fixed in position by a mental compress and occipito-frontal bandage, thus securing the jaws from motion and the splint from displacement. The compress consists of a light piece of wood, on which is fixed a metallic cup of form and size adapted to the patient's chin, to each extremity of which is affixed a metallic side-piece four or five inches in length and from three-quarters to one inch in width. Encasing these side-pieces are the temporal straps, made of stout cloth and secured by a strong cord at the base of each piece. The occipito-frontal bandage is composed of a band passing around the head from the forehead to the occipital protuberance behind, and secured by a buckle one inch to the right of the median line behind; of another strap secured to the band in front and behind; and a third strap extending from the temporal buckles on either side and secured to the middle strap at the point of crossing. (See Fig. 590.)

FIG. 590.

An "impromptu interdental splint," the suggestion of Professor Gorgas, and which he has employed with great satisfaction in hospital practice, both in the case of single and double fractures of the maxillæ, is described as follows:—

Taking the case of fracture of the inferior maxillary, for example, after all the parts are brought in apposition and secured by wire or silk ligatures, a partial lower mouth cup or tray, of the proper size to suit the arch, is selected. This mouth cup is of the form having an opening or cavity to allow the front teeth under other circumstances to pass through, or, what is better, is cut out in the form represented by Fig. 591 for the lower jaw and Fig. 592 for the upper jaw.

The partial lower cups with flat bottoms and square sides are more suitable than the round-bottom cups, but the latter may be used with advantage where the jaw is edentulous.

When the fractured portions are secured in position by ligatures, the cup is filled with softened modeling composition and introduced into the mouth in the same manner as when taking an impression for a partial lower set of teeth and pressed carefully into place. The opening or cavity in the front part of the cup will allow the modeling composition to press through the upper surface, and into this excess the patient is directed to bite with the superior front teeth, and the modeling composition is adapted by pressing on it with the finger to the labial surfaces of these teeth. This completes the formation of the interdental splint, which the patient is to wear until union of the fractured parts takes place. The handle of the cup, which is necessary for its introduction into the mouth, is then cut off close to the cup with a fine saw, in order that it may not inconvenience the patient by projecting beyond the lips. The openings on each side over the bicuspid and molar teeth will permit the introduction of nourishment without disturbing the appliance. A bandage is then passed over the top of the head and under the chin, and thus an easy and rapidly formed "interdental splint" is improvised, which has given satisfaction in every case where it has been applied, and permitted of removal in from three to four weeks from the time it was applied. Special splints with an adjustable handle, which may be removed by unscrewing it, have been devised by Professor Gorgas, for the treatment of fracture of both jaws, which are better adapted to the parts than the ordinary mouth cups employed for obtaining impressions in the construction of sets of artificial teeth.

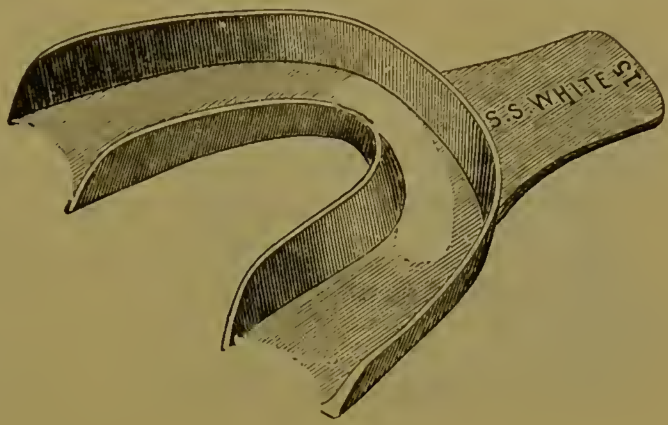


FIG. 591.

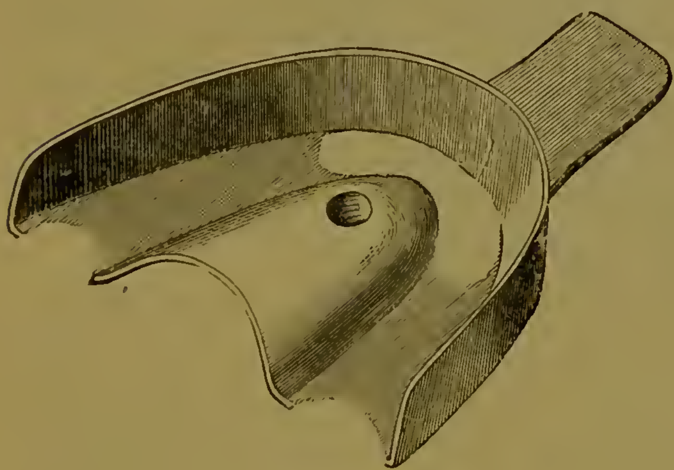


FIG. 592.

Dr. Edward H. Angle's system of treating fractures of the maxillary bones is as follows :—

"The most important consideration, after securing perfect apposition of the parts, is that they shall have uninterrupted rest, and this phase of the subject will be set forth strictly with reference to certain plans for securing fixation of the fractured maxillæ while undergoing the healing process; plans which are original with the author, and have been successfully employed in an extensive experience in the treatment of these lesions.

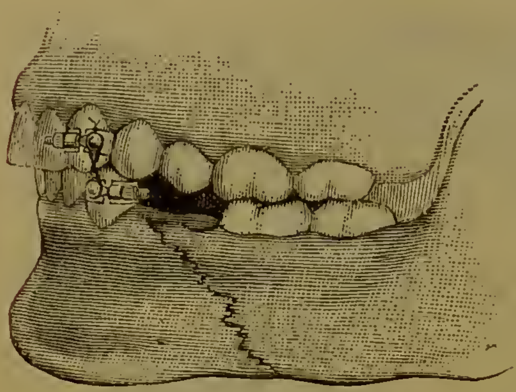


FIG. 593.

"The first plan is that of firmly and immovably holding the injured jaw in contact with the firm and uninjured jaw by means of wire ligatures wrapped in the form of the figure eight around buttons attached to bands encircling suitable opposite or nearly opposite teeth, as shown in Fig. 593.

"All the teeth are thus kept in perfect occlusion, and, as a result, the fractured ends of the bones must necessarily be in apposition, so that the conditions are most favorable to the process of repair; for it will be apparent upon reflection that no matter at what point the fracture has occurred, if the jaw contains sufficient teeth and they are placed in perfect occlusion, not only will the fracture be properly set, but the powerful muscles will be greatly relaxed and the parts be consequently freed from that tension and tendency to displacement so difficult to combat in the treatment of fractures, in the long bones especially, or in the maxillæ when the jaws are kept apart, as is necessary when the heavy interdental splints are employed.

"Indeed, we believe this plan to be a most natural and easy one, for the cusps of the teeth lock and interlace so perfectly that displacement in any direction is impossible, provided the jaws are kept closed. And in this we are further assisted by the natural contraction of the powerful muscles of mastication, it being necessary in most cases only to antagonize the anterior, feeble depressor muscles, by attachments on each side to the cuspids, or other teeth in this region, if more suitable.

"The bands, which we term fracture-bands, Fig. 594, are made very thin and strong, are adjustable, and, by means of the screw and nut, they may be firmly clamped about the teeth. Little buttons, strong and of sufficient size to admit the requisite number of wraps of the ligatures, are firmly soldered to the band. Care should always be exercised to work the band well over the crown of the tooth and down

upon the neck, then tighten the nut until the band is firmly clamped, being careful not to weaken the band by crimping or tearing. The fingers alone are usually sufficient, although a dull instrument and mallet may be used to assist in placing the band. If the teeth are crowded, a thin spatula pressed between them and allowed to remain for a few moments will provide ample space. For the ligatures, almost any of the usual materials may be employed, such as waxed floss silk, strong linen thread, or the gut ligature so extensively employed in surgery, but fine copper wire is preferable on account of its strength, pliability, and cleanliness.

FIG. 594.

"That the reader may become more familiar with this method of treatment, as well as with a few of the many modifications of which it is susceptible, reports of a few cases from practice are subjoined, with illustrations from models made accurately in each instance after treatment.

"*Case I.*—The first is represented by Fig. 595.

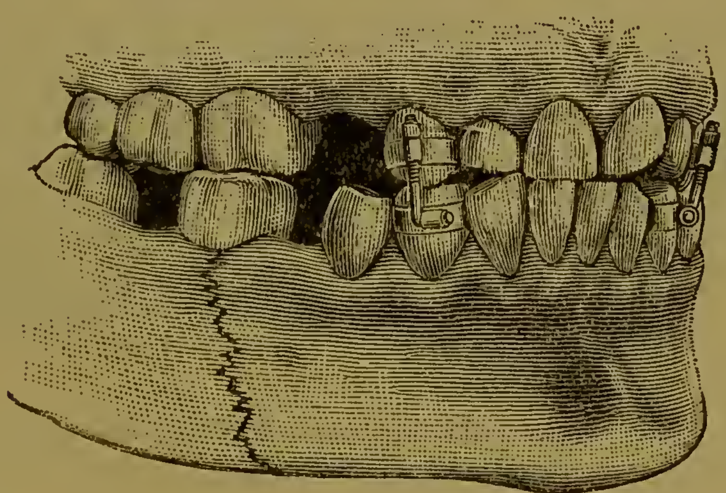


FIG. 595.

"On July 14, 1889, Wm. Fraley, aged forty-five, was admitted to the Minneapolis City Hospital. A blow from a policeman's club had produced one simple and one compound fracture of the inferior maxilla. The first was an oblique fracture on the right side, beginning with the socket of the second bicuspid, extending downward and backward, and involving the socket of the first molar. The second bicuspid had fallen out, and the first molar was much loosened. The second molar had been lost years before, while the third molar and the remaining teeth were much abraded, and much loosened by salivary calculus. The second

fracture was on the opposite side, high up in the ramus of the jaw. I could not detect the exact course the line of fracture had taken, but the crepitation of the ends of the bones, and the pain occasioned thereby, were unmistakable evidence of a fracture. The patient, as is usual in such cases, was unable to close his jaws. The parts on the right side were widely separated, and the anterior piece much depressed by reason of the action of the digastric muscle, the posterior piece of bone being drawn firmly up, and the molars occluding by reason of the contraction of the masseter muscle. He was treated as follows:—

"Bands were made to encircle all four of the cuspids (they being most firmly attached in their sockets). The fractured ends of the bones were placed in careful apposition, and the lower jaw closed, the lower teeth being correctly occluded with the upper.

"The points on the bands, where the little tubes (C, Set No. 1) shown in the engraving should be attached, were carefully noted and marked. The bands were slipped off and the tubes soldered to them, after which the bands were cemented in proper position upon the teeth, and two small traction-screws (B, Fig. 273), shown in the engraving, inserted in the tubes. The jaws were closed and the nuts tightened.

"During an attack of coughing the following night, one of the bands was loosened, but it was easily replaced the next day. No further accident or trouble occurred, the patient readily taking nourishment through the spaces between the teeth. Thus the fractured jaw was firmly supported without motion for twenty-two days, when the appliance was removed, showing most excellent results.

"That the patient was a great lover of the clay pipe is shown in the engraving by the much worn ends of the lateral incisors, which resulted from holding the stem of the pipe. While wearing the appliance he was not debarred from his favorite enjoyment, although compelled to grasp the stem between his lips instead of the teeth.

"*Case II.*—December 28, 1889, Thomas Bremen was admitted to the Dental Infirmary of the University of Minnesota, suffering from the effects of a blow received on the left side of the jaw from a canthook while working in a lumber camp. The result was two fractures of the jaw.

"The first fracture was on the right side, beginning between the first and second bicuspids and extending downward and backward so far as to involve the lower part of the anterior root of the first molar. The second was on the left side directly through the angle of the jaw (see Fig. 596). The accident had occurred thirty-two days previous to his admission to the infirmary, during which time nothing had been done to reduce the fracture. He reported that he had called upon a physi-

cian, who supposed the trouble was merely an abscessed tooth and had lanced the gum with a view of reducing the swelling. Later, the patient had called upon a dentist in one of the smaller towns, who also failed to diagnose the fracture, and extracted *both* bicuspids in the hope of giving relief.

"Upon examination I found considerable swelling in the region of the fracture, with the usual result: the patient being unable to close his mouth by reason of the anterior piece of the fractured bone being drawn down by the depressor muscles. A false joint had also become established, and could be easily moved without causing pain. At the fracture of the right side there was but little displacement; the swelling also was slight.

"The patient was anesthetized, and, with a view to breaking up the false attachments and stimulating activity in repair, the ends of the

FIG. 596.

bones rubbed forcibly together, placed in perfect apposition, and the jaw closed, great care being taken to articulate the teeth correctly with the upper ones. The jaw was now firmly bound in this position in the same manner as described and shown in Fig. 593, which is quite as efficient and much easier to adjust. Four bands were used, encircling the four cuspids, as shown in Fig. 596. The bands shown upon the molars in the engraving were not used, as I found them unnecessary, since the jaws were firmly supported by the anterior band alone.

"Case No. 3 is represented by Fig. 597, and is that of a healthy young Swede, twenty-two years of age, who, while washing windows, had fallen from the second story to the hard pavement. Besides receiving several minor injuries he sustained a double fracture of the lower jaw, one extending from between the central incisors, and one posterior to the second molar, the third molar having been extracted.

The right superior lateral and cuspid were knocked out, the first bicuspid broken off near the neck, and the alveolar process badly shattered. The centrals and left lateral were bent inward and forced deeper into their sockets. He had been treated by the attending physician at the City Hospital, the method employed being that of the Barton style of bandaging, with the usual result, when the bandage is employed in such cases, of aggravating the condition by forcing the pieces inward and the jaw backward.

"Upon examination three weeks after the accident, I found much displacement. The jaw was drawn backward and the right middle section of the bone tipped inward. No attention had been paid to the bent and broken condition of the superior alveoli. The teeth had become quite firm in their new but abnormal positions, and I allowed them to remain so. A fibrous attachment had been established in the lower fracture, which admitted of considerable movement, and occasioned but little pain. There was much swelling, and pus was discharging into the mouth from the anterior fracture. I found it impossible to restore normal occlusion at that time. Bands were made to encircle the four bicuspids, and between the two lower bands, on the inside of the mouth, was placed one of the jack-screws (E and J, Set No. 1), held in place by the staple and spur (E, Fig. 286, and B, Fig. 285). The nut was tightened until the piece of bone had been tipped outward about one-half the distance to its normal position, but the operation caused so much pain that further movement was deferred. The jaws were then closed and the buttons connected by ligatures, but occlusion was far from being normal. On the next day, by again tightening the nut on the jack-screw and with

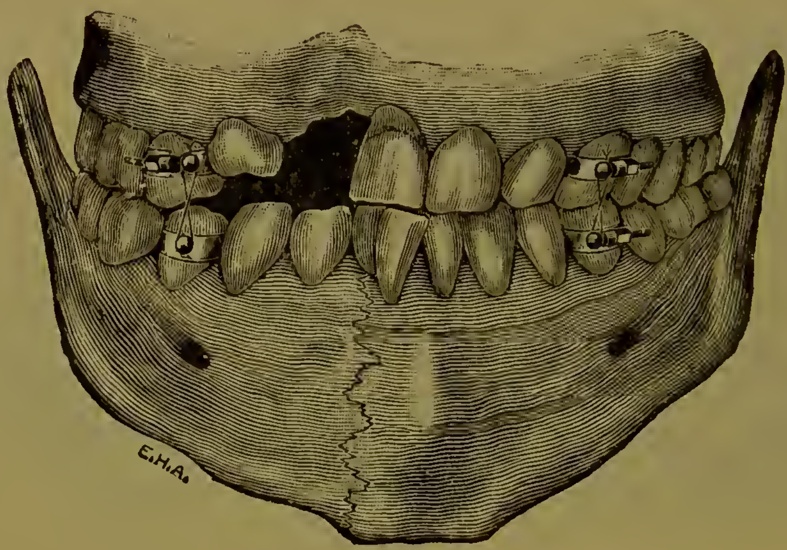


FIG. 597.

renewed ligatures bound very tightly, I was enabled to secure nearly the normal occlusion. On the third day following, by the same means, correct occlusion was established. The jack-screw was allowed to remain in position to steady the tipping section.

"The abscess was frequently syringed with fresh peroxid of hydrogen. A few fragments of bone were washed out. The fractures readily united, and on the twenty-seventh day the jaw was released and found to be quite firm.

"Case No. 4 shows another modification, and is represented by Fig. 598. A young machinist received a severe blow from the fist of an antagonist, by which two compound fractures were sustained,—one posterior to the first molar, the other in the region of the cuspid, which was involved and greatly loosened. Occlusion was established and maintained in the previously described way. Suppuration

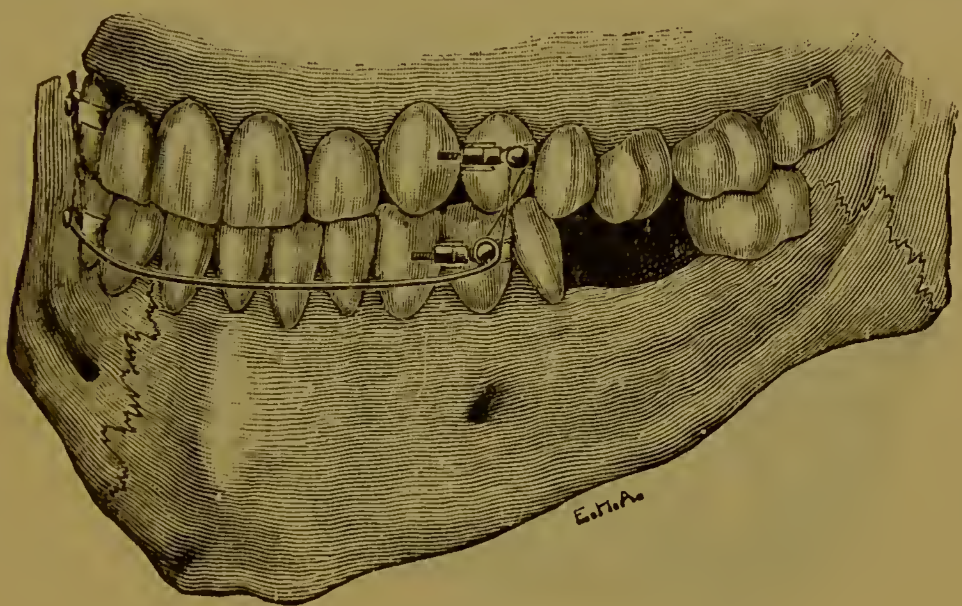


FIG. 598.

occurred in both fractures on about the tenth day, and received proper treatment. The union of the anterior fragment was slow, as the patient was troubled by a persistent, hacking cough, which occasioned a slight movement between the ends of the bone, just sufficient to interfere with the healing process. On the twentieth day the ligatures were cut, a jack-screw placed in position between the bands on the inside in the same manner as in Fig. 597, with an additional ligature firmly connecting the two buttons on the lower bands, and resting in contact with the labial surfaces of the intervening teeth. This additional support proved successful; the union proceeded slowly, and was found complete when the bands were removed on the sixty-second day after the accident.

"Another modification is shown in a somewhat peculiar case, repre-

sented in Fig. 599. The patient, a man of about forty years of age, had sustained a complete fracture of the left angle of the jaw, as the result of a kick from a horse. The jaw was enormously large and protruding, and the occlusion so unusually faulty, that I was at a loss to determine what the patient's normal occlusion was; but upon questioning him, he informed me that when a boy of ten years he had been hit with a stone, causing a fracture on the right side of the jaw, which had been allowed to heal without any treatment. This statement, with the worn facets upon the cusps of some of the teeth, and the readiness with which they occluded only at these points, showed conclusively the position in which the jaw must be secured. I at first, of course, supposed that the usual number of four bands and two ligatures would be necessary, but I found the single ligature, as shown, was quite sufficient to firmly retain the jaw in this abnormally normal

FIG. 599.

position. The jaw was set a few hours after the accident. Very little swelling ensued, the fractured parts uniting rapidly. I saw the patient but four times, and removed the bands on the twentieth day, as further support seemed unnecessary. I admonished the patient, however, to avoid using his jaw as much as possible for at least ten days thereafter.

"Fig. 600 represents a case where the patient suffered in a railroad wreck two compound fractures of the inferior maxilla, one on each side, posterior to the second molar. The left side was quite badly comminuted. The full complement of teeth was present, with the exception of the third molars. The occlusion of all the teeth was excellent. The incisors, however, were crossed (not well shown in this engraving); that is, the left superior central and lateral closed

just inside of the points of the lower incisor and cuspid, while the right central and lateral closed just outside of the points of the opposing lower cuspid, central, and lateral.

"The teeth being so perfect and the occlusion so accurate, liquid foods only were possible. The conditions were made more unfavorable on account of the patient suffering from severe spinal injury received at the time of the accident, but with the exception of considerable suppuration in the left fracture, which yielded readily to treatment, nothing unusual occurred. The ligatures were removed on the fortieth day, and excellent results were apparent.

"It might be urged against a method of treatment which involves the closure of the teeth and the binding of the jaws firmly together, that the patient would be unable to take sufficient nourishment. Experience, however, shows that this argument has practically no founda-

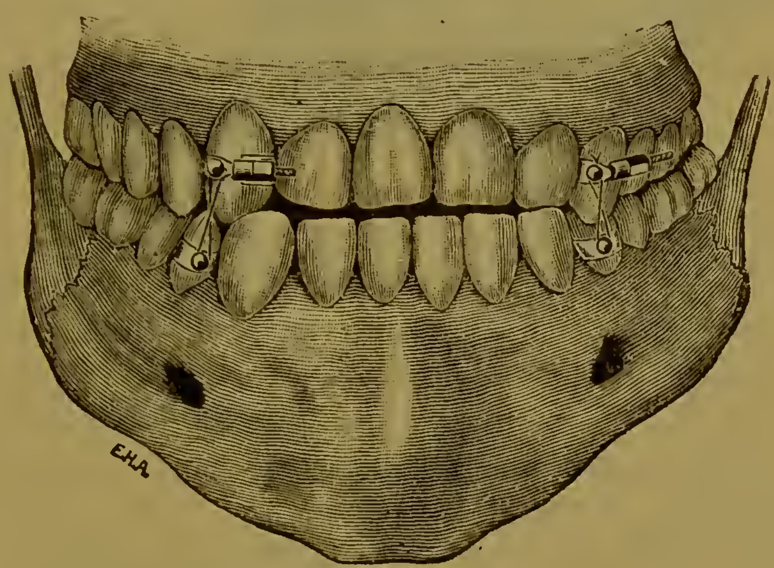


FIG. 600.

tion, for it rarely happens that a patient is found without some missing teeth, thereby providing abundant opportunity for the inception of all ordinary chopped foods, and more especially for the large number of foods now available in liquid form. Even when all the teeth are sound and in perfect position, there is plenty of space between the teeth, or behind the molars and between the upper and lower incisors, for taking all the nourishment necessary. Of course, in these rare cases more time would be required for eating. This inconvenience is very slight when we consider the advantages of freedom from an uncleanly, bulky, and inconvenient apparatus within the mouth, often accompanied by the disfigurement of bandages and splints without, as well as the great importance of the accuracy in results which it assures, so uncertain of attainment in many other methods commonly employed.

"There is also another class of lesions in the treatment of which this

plan of fixation may be employed to great advantage. I refer to excision of the lower maxilla, or those cases where a large portion of the jaw has been removed, as in Fig. 601.

"In all these cases there is a strong tendency for the remaining portion of the jaw to be drawn greatly to one side (about three-quarters of an inch, by actual measurement, in the case represented), due to the contraction of the cicatricial tissues following the healing of the wound. The plan I propose will prevent this contraction, by securing the remaining portion of the jaw in proper occlusion, by means of the fracture-bands and ligatures in the manner already described. The jaw thus firmly held will exert sufficient tension upon the healing muscles to prevent their contraction. I would also suggest the advisability of increasing the tension by the attachment of a plumper, by means of a clamp-band, to one of the molars in the upper jaw on the side from which the section has been removed, allowing the shield or plumper to extend downward and outward, to occupy somewhat the position of the missing bone. This shield may also serve a useful purpose in holding in better position the dressing of the wound.

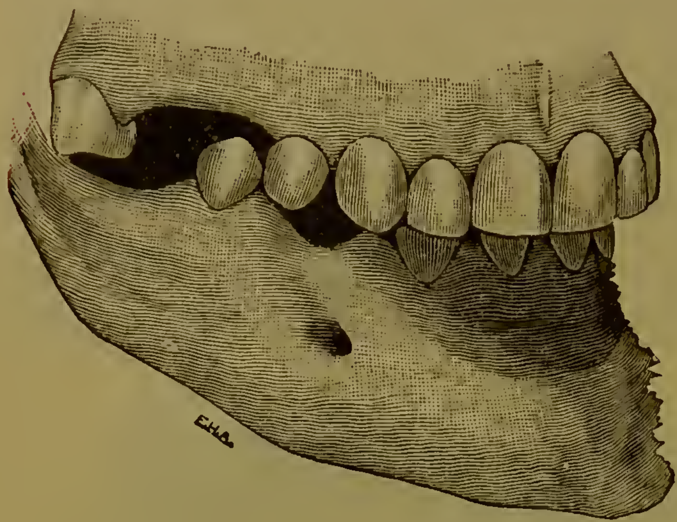


FIG. 601.

"The next plan may be said to be a modification of, or an improvement upon, the plan advocated by Hippocrates in the fifth century B. C., and which has been employed from that time to this. It consists in holding the fractured ends of the bone in apposition by wrapping ligatures about the teeth, or, as physicians now term it, wiring the teeth. The principal disadvantage has always been the slipping of the ligatures, which produced displacement

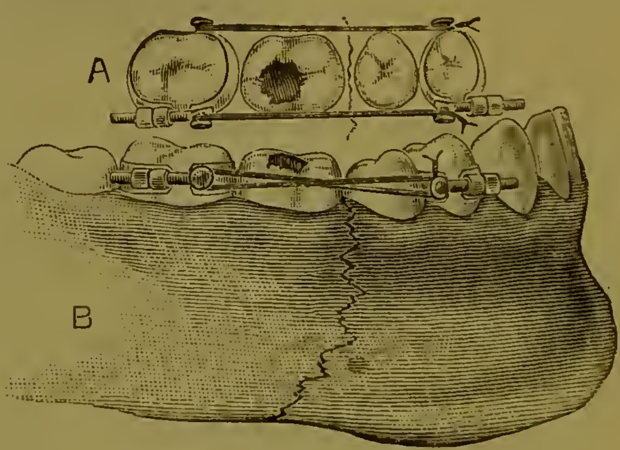


FIG. 602.

of the bones, and caused inflammation by the pressure of the sliding ligature upon the gums.

"My plan is shown in Fig. 602, and consists in encircling suitable teeth with fracture-bands and attaching ligatures to the buttons upon the bands, so that loosening of the bones or pressure upon the gums is impossible.

"A modification of the plan is shown in Fig. 603, in which additional support is secured by connecting the labial and lingual wire ligatures by loops of wire passed between the teeth, with their ends united by twisting.

"In favorable cases, as in simple transverse fractures with little or no displacement and where the teeth are very firm, if the apparatus is adjusted with skill, the plan will be found valuable, as it is very neat,

FIG. 603.

clean, and compact, and does not interfere with the freedom of the jaw.

"A few suggestions may assist the inexperienced in the adjustment of the apparatus, so that it will surely afford equal pressure and support upon the intervening teeth. The only difficulty is in regard to the proper length of the lingual ligature when completed. This is easily overcome by using two small copper wires, passing respectively above and below the buttons and extending beyond them a half-inch or more at each end. Tension is not exerted on the buttons by uniting the ends by twisting until *after* the external and transverse ligatures have been completed. The engraving is incorrect in this respect, that only one end of the lingual ligature shows union of the ends, instead of both.

Fig. 604 represents a modification of this plan used for holding in position a large section of the alveolus, including the incisors and left lower cuspids, which had been broken outward as the result of

falling from a sled while the individual was coasting with the knotted end of a rope held in the mouth. The second bicuspids were banded, and a wire ligature made to encircle the buttons and bear against the loosened teeth. The ligatures showed a slight tendency to slide down and impinge upon the gum, but this was easily remedied by encir-

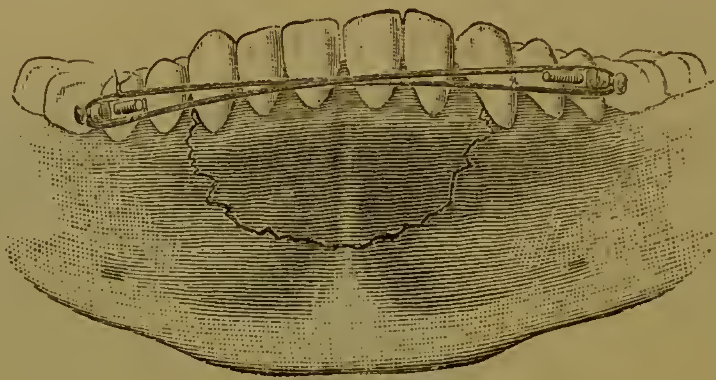


FIG. 604.

cling the main ligature and the incisors with two or three fine wire ligatures, thus giving additional support in a downward direction.

"Fig. 605 shows another plan for securing fixation which possesses several valuable features. It is a thin metal cap, swaged to fit the crowns accurately and covering a sufficient number of the teeth in the

FIG. 605.

arch to afford the necessary support, the whole being firmly cemented to the teeth with oxyphosphate of zinc. Copper, gold, silver, aluminum, or vulcanite may be used; my preference is aluminum. The plan is excellent, in that it allows fredom of the jaw, is very clean, com-

pact, and retains the fractured ends of the bone firmly in apposition. Considering the simplicity of this appliance, and the familiarity of dentists with oxyphosphate of zinc, it is surprising that the value of this idea in treating fractures has not been before recognized; but I find no record of its use, although dentists frequently use similar splints in the retention of teeth after they have been regulated, and Hullihen employed a similar device in 1848 to hold the section of a jaw after a surgical operation, using ligatures to keep the appliance in place.

"For several years I supposed I had been the first to employ this method of retaining fractures, but I now believe it was first used by Dr. John H. Martindale, of Minneapolis, who preceded me a year or so, by cementing in position a splint made after Kingsley's pattern, in order to dispense with the submental cap and bandages, which

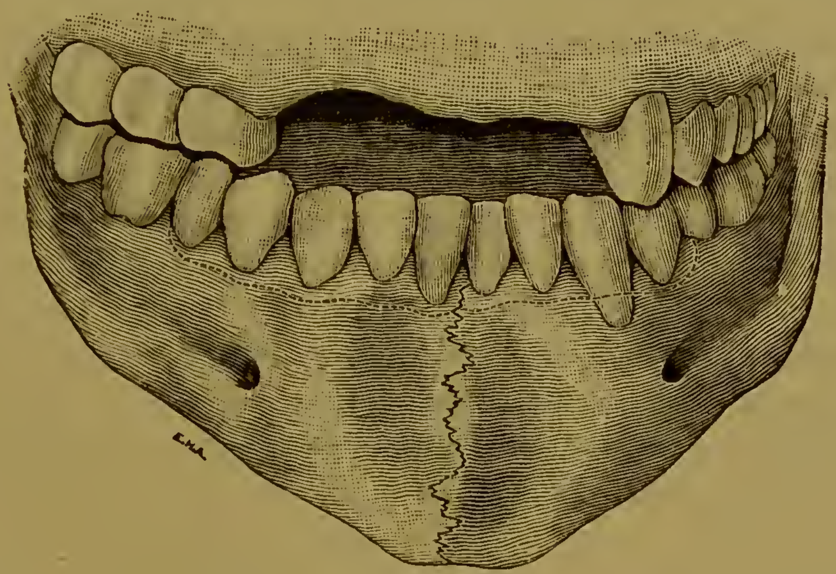


FIG. 606.

would interfere with the treatment of serious external wounds on the side of the face.

"My first case treated after this method is shown in Fig. 606. Michael P., a baker by trade, had fallen down stairs, knocking out the superior incisors, cuspids, and one bicuspid, also loosening the lower central incisors and fracturing the jaw at the symphysis. As I remember, he also received a fracture of one of the femurs. He was admitted to the Minneapolis City Hospital some time in June, 1888. I saw him first some two months after the accident occurred, during which time the attending surgeon had employed the Barton style of bandaging in treatment. Union of the bone had not taken place; on the contrary, a complete fibrous joint had been established, with the ends of the bones more or less absorbed and rounded, admitting of a free hinge movement, with pus discharging, for which a large

rubber drainage-tube had been inserted. The tube was removed, the wound thoroughly washed, and an impression taken without any attempt at changing the collapsed condition of the sides of the arch. A model was made and sawed through at the point of fracture. It was then placed in the articulator and adjusted to restore the original occlusion as nearly as possible. Over this readjusted model a very thin vulcanite splint was formed, the outlines of which corresponded to the dotted lines in the engraving.

"The first attempt at cementing it in position upon the teeth was unsuccessful, the cement hardening too rapidly, but the next proved successful. The splint remained in position without any trouble for nearly four months, when it worked loose, and we found, upon examination, that firm union had taken place.

"Of course, the range of usefulness of this splint is quite limited, as a sufficient number of firm teeth must be present on each side of the fracture. Its principal value will, I think, be found in treating fractures in the anterior part of the jaw, more especially in that class of cases resulting from gunshot wounds in which large sections of the alveolus have been carried away.

"Another plan which I have made use of in a few favorable cases with much satisfaction is shown in Fig. 607, which represents my first case treated by the method in question. On May 29, 1889, a young man of twenty-one years was admitted to the St. Anthony Hospital of Minneapolis. During an attack of epilepsy he had fallen from a lumber pile to the ground, a distance of fifteen or twenty feet. Besides receiving severe bruises, he sustained a compound fracture at the symphysis, terminating in front between the central and lateral, as shown by the line in the engraving. The fractured bone, when first seen, was quite widely separated at the top, and the left central incisor was much loosened. He was treated as follows: The ends of the fractured bones were carefully placed in position and temporarily fastened by lacing the teeth together with silk ligatures. The cuspids, being very firm, were carefully fitted with plain bands. Tubes were soldered to these bands horizontally. The large traction screw shown at A, Fig. 273, was now slipped through the tubes, and the bands were firmly cemented in position upon the teeth. The nut was then turned upon the screw until the fractured ends of the bones were

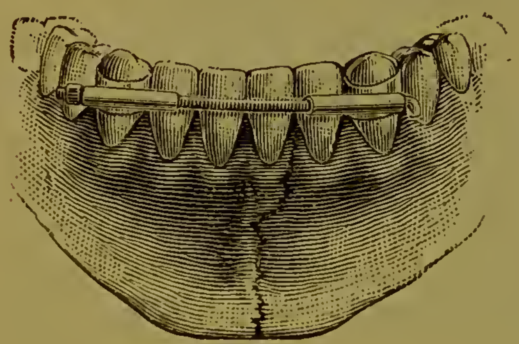


FIG. 607.

drawn snugly together. This appliance was worn without displacement or further trouble for twenty-one days, when it was removed, the bones having become firmly united.

"I may add that during the time the appliance was worn, so firmly was the jaw supported that the patient suffered but little inconvenience, and after the third day partook regularly of his meals, using his jaws freely, but of course avoiding the very hard foods.

"*Suggestions.*—In adjusting bands for the treatment of a fracture, carefully consider the direction in which to exert the proper pressure for securing the jaw. It usually happens in cases of fracture that the muscles in contracting tend not only to depress the jaw, but to draw it backward, especially if the fracture be in the region of the last molar. Consequently such teeth for anchorage should be selected as shall use pressure not only upward but forward, as in Fig. 599.

"This is only a general rule, however, but I would specially advise that the direction of force necessary in each case should be carefully considered, and then the bands and buttons be adjusted accordingly.

"Sometimes it is an advantage to band more than one tooth in order to distribute the power exactly in the direction necessary. Should any of the teeth which have been selected for anchorage show a tendency to elongation, the bands should be shifted to other teeth, or the direction of the force be changed. In but two instances have I noted this complication, and I am inclined to believe that one of the cases was due to the band slipping and impinging upon the gum, and thus probably producing the same result as when a ligature is carelessly left about the tooth.

"Should it be found advisable to employ the plan illustrated by Fig. 606 or Fig. 607 in the treatment of a case, it will sometimes be found an advantage to support the jaw by the first plan (Fig. 593), for a few days, or until the wounds are in more favorable condition for taking an impression or adjusting the apparatus.

"After the jaw has been properly set, the muscles relax in a few hours, so that the strain upon the ligature and anchor-tooth is slight.

"Very often patients receive severe bruises and internal injuries at the time the fracture is sustained, and these may occasion vomiting, more or less violent. Therefore especial caution should be observed that the securing of the jaw be delayed until all tendency to nausea has subsided. Be in no haste, for I know of no ill effects from a few hours' or even days' delay in setting a fracture. Should it be advisable to immediately set the fracture, it might be well to provide the attendant with a pair of strong scissors to cut the ligatures if symptoms of nausea develop.

"It should require but little argument to impress the importance of

extreme cleanliness about the mouth during the treatment of fractures. Frequent rinsing of the mouth with proper antiseptic solutions should be insisted upon. If the fracture is more or less comminuted, as is frequently the case, suppuration may be expected. The plan, then, which has been the most successful with me, is extra cleanliness of the wound by frequent injections of pure, fresh peroxid of hydrogen with a suitable syringe. The patient or the attendant, with a little experience, can accomplish this quite as well as the surgeon. Patience and persistence in this line will soon cause the necrotic fragments to be washed out. Only in one instance, in my experience, has it seemed necessary to interfere with the wound by scraping the bone with instruments.

"While the patient is undergoing treatment, his general health should also not be allowed to become impaired. Plenty of exercise in the open air, if other injuries do not prevent, should be insisted upon, as well as a requisite amount of nourishing food, and the surgeon should occasionally inspect the bands and ligatures to see that they are in order, so that the jaw shall not be allowed to get loose, admitting movement between the fractured ends of the bones. Should one of the bands become broken, it should be replaced as quickly as possible. No special harm will come from cutting the ligatures and separating the jaws for the purpose of replacing it.

"In cases where a section of the bone shows a tendency to lean, so that the teeth do not properly occlude, a finger of metal, made to bear against a tooth in the leaning section and soldered to a band encircling some favorably located anchor-tooth, will effectually restore the proper occlusion.

"In like manner the range of application of this method of retaining fractures may be extended to cases where fractures occur in the body of the bone and the molars are absent. The edentulous portion of the jaw may be securely held in proper position by a prop made to bear against the section of bone, and kept in place by attachment to a band secured about one of the molars or bicuspids in the upper jaw.

"The methods so far offered will, I believe, nearly cover the entire range of cases requiring treatment. There still remains, however, one distinct class for consideration, namely: the edentulous patient. Fortunately, patients of this class requiring treatment are exceedingly rare, and probably the best plan is the Gunning splint, or what is the same in principle, attaching together by wire or vulcanite the artificial dentures, should the patient possess them.

"The cases of fractures so far described have been confined to the inferior maxilla. The methods, however, of securing fixation are all more or less applicable to the treatment of fractures in the upper jaw

as well, though I believe the one first described is most applicable; for the reason that, if one of the superior maxillary bones is fractured, it will be more or less displaced and usually forced downward. After carefully replacing the pieces, the jaws are closed and the teeth articulated, and the pieces thus supported and held upward in position by the lower jaw secured in the usual way by bands, buttons, and ligatures, attached on the uninjured side.

"Finally, as all the apparatus possessing any special merit in the treatment of fractures of the maxillæ have been invented by dentists, and their familiarity with the parts, special knowledge of mechanics, and facilities at their command fit them above all other surgeons for this work, I would recommend that the different dental societies throughout the country shall secure appointments of competent dentists in all hospitals for the treatment of these lesions. for to them this special line of surgery justly belongs."

CHAPTER IX.

DISEASES OF THE ANTRUM.

The cavity known as the antrum of Highmore, or maxillary sinus, is situated in the body of the superior maxillary bones, on either side of the nose and beneath the orbit of the eye. It is an irregular cavity, varying in size in nearly every superior maxillary bone, and often divided into several parts by vertical partitions (septi) of bone, an observation of many bones being necessary to show its extent and general form. The alveolar process immediately over the ends of the roots of the first and second superior molars and bicuspids forms the floor of the antrum; hence it is readily seen how abscesses of the roots of these teeth may involve this cavity.

One of the nasal openings of the antrum, of which there are two in the middle meatus of the nose, when in a normal condition, is very nearly closed by a duplicature of the membrane lining the turbinated and other adjoining bones, and secretions may readily accumulate when this outlet into the nose is closed by congestion of the membrane, giving rise to serious symptoms, such as disfigurement, pain, etc. The other opening is very small, and can only be entered with the point of a probe. The mucous membrane which lines the nares passes through these openings into the antrum, and lines this cavity also.

The antrum is subject to some of the most formidable and danger-

ous diseases the medical or surgical practitioner is ever called upon to treat; and yet there are few diseases incident to the human body that have received less attention from writers on pathology and therapeutics than these. There are diseases here met with over which neither the surgeon nor physician can exercise any control, the progress of which ceases only with the life of the unfortunate sufferer.

All of the diseases to which the maxillary antrum is subject, however, are not of so dangerous a character, for some are very simple and easily cured; but even those which are regarded as the least dangerous, and which yield most readily to treatment when instituted during their incipient or earlier stages, may assume, if neglected or improperly treated, a form so aggravated as to bid defiance to the skill both of the physician and surgeon. While thus, on the one hand, the most simple affections of this cavity may, by neglect or improper treatment, become ultimately incurable, many of those, on the other hand, which are considered the most malignant and dangerous, might, we have no doubt, by timely and judicious treatment, be effectually and radically removed.

The form which the disease puts on is determined by the state of the constitutional health or some specific tendency of the general system; and we can readily imagine that a cause which, in one person, would give rise to simple inflammation of the lining membrane, or mucous engorgement of the sinus, would in another produce an ill conditioned ulcer, fungus hematodes, or osteo-sarcoma. Simple inflammation and mucous engorgement not unfrequently causes caries and exfoliation of the surrounding osseous tissues, and, in some instances, even the destruction of the life of the patient.

The importance of early attention to the diseases of this cavity is, therefore, very apparent; and this is the more necessary as it is often difficult and sometimes impossible to determine the character of the malady until it has progressed so far as to involve, to a greater or less extent, the neighboring parts, when, if it has not become incurable, its removal is, to say the least, rendered less easy of accomplishment. It may be safely assumed, therefore, that in a very large majority of the cases of diseases of the maxillary sinus, the danger to be apprehended arises more from neglect than from any necessarily fatal character of the malady, so that in forming a prognosis, the circumstances to be considered are the state of the constitutional health. the progress made by the affection, and the nature of the injury inflicted by it upon the surrounding tissues. If the general health is not so much impaired as to prevent its restoration by the employment of proper remedies, and the neighboring structures have not become implicated, the prognosis will be favorable; but if the functional operations

of the body have become very much deranged, and the bones of the face and nose seriously affected, the combined resources both of medicine and surgery will prove unavailing.

In young and middle-aged subjects of good constitution, a morbid action may exist in the antrum for years without giving rise to any alarming symptoms, while the same affection in another less healthy might rapidly extend and degenerate into a form of disease so malignant as to threaten the speedy destruction of the life of the patient. Medical history abounds with examples of this kind, and conclusively establishes the fact that the state of the general health and habit of body, whatever may have been the primitive characteristics of the malady, ultimately determines its malignancy; in the treatment of affections of this cavity, therefore, as well as of other local diseases of the body, the condition of the system should not be overlooked.

Independently of the danger arising from the local affection, diseases of the antrum are, for the most part, very loathsome, and subject the patient to great annoyance. They change the quality of its secretions, and cause them to exhale a fetid, nauseating odor. This, in many instances, is almost insufferable to the patient, and when they are prevented from escaping through the natural opening into the nose, they pass through one artificially formed by the surgeon, or made by the disease through the cheek, alveolar border, or palatine arch, always causing the patient great inconvenience.

The progress of disease in this cavity is often very insidious. It not unfrequently happens that it exists for weeks and even months before its presence is suspected. The slight uneasiness felt is attributed to some morbid condition of the teeth or gums, and the symptoms attendant upon one description of affection are often so similar to those that accompany another, that it is impossible to determine its true character until it has made considerable progress.

The morbid affections of the maxillary sinus are, for the most part, similar to those of the nasal fossæ.

The most simple form of disease that occurs here is inflammation of the lining membrane, and this, in most instances, may be said to precede all others. It often subsides spontaneously; but when it continues for a long time it is apt to become chronic, and may then give rise to other and more formidable kinds of disease. When unattended by any other morbid affection, either local or constitutional, it is easily cured.

A purulent condition of the fluids of the antrum is a common affection, but is seldom met with in persons of good constitution. It seems to be dependent upon a bad habit of the body; also upon inflammation of the mucous membrane of the sinus, which arises

more frequently from dental irritation than any other cause. This condition of the secretions sometimes gives rise to caries and exfoliation of portions of the surrounding bone and to fistulous ulcers; but when dependent upon no other local cause than simple inflammation of mucous membrane, it is seldom that such effects result from it. When complicated with other morbid conditions of the cavity they are not infrequent.

Ulceration of the lining membrane is an affection less frequently met with. It is rarely, if ever, idiopathic, but seems rather to be dependent upon some other local malady or some specific constitutional vice. Scorbutic and scrofulous diatheses, and those affected with a venereal taint, are more liable to ulceration of this membrane than persons of sound constitution. Consequently, it is seldom cured by local remedies alone. It is almost always complicated with fungus of the membrane and caries of the walls of the sinus, and may, if neglected, take on a cancerous form and become incurable.

The next form of disease is caries of the antral parietes. This, though always complicated with other forms of diseased action, seems, nevertheless, to be worthy of separate consideration. Like ulceration of the lining membrane, it is the result of some other affection. It may result from accumulation of the secretions of the sinus, from ulceration, or from tumors.

The occurrence of fungus or polypus and of various kinds of tumor is less frequent than any of the preceding affections; yet this cavity is not exempt from them, and they constitute the most dangerous form of disease to which the superior maxilla is subject. Although it is probable that in their incipient stage they might in nearly every instance be radically removed, it is seldom they are cured after they have attained a very large size, and have implicated to a considerable extent the surrounding tissues. They have, however, been successfully extirpated even after they had acquired great volume, and implicated to such an extent the surrounding parts as to render necessary the removal of the whole of the superior maxillary bone. They usually grow with great rapidity, and if not completely removed are soon reproduced.

Besides these, other varieties of disease are occasionally met with here. The antrum is liable to injuries from blows and other kinds of mechanical violence, and from the introduction of insects and foreign bodies. The diseases of the maxillary sinus are supposed to be dependent upon certain specific constitutional vices; upon the obliteration of the opening of this cavity into the nose, and upon dental irritation. That all of these may at times be concerned in their production is more than probable. But actual disease rarely develops itself spontaneously as a consequence merely of a bad habit of body or constitu-

tional vice. This does not of itself originate disease, but only occasions an increase of susceptibility of the tissues to morbid impressions; so that when an unhealthy action is once induced here, a more aggravated or a different form of disease occurs than that which would otherwise have been produced.

Thus it may be seen that disease of the maxillary sinus is dependent upon some exciting cause, favored by some constitutional vice; for without this no serious morbid effects would be produced, or if produced, they would be of a different or less aggravated character. Any disposition or vice of body which weakens the vital energies of the system increases the susceptibility, or rather *excitability*, of all its parts —those of this cavity equally with the rest. There are various kinds which have this effect; as, for example, the scorbutic, scrofulous, venereal, mercurial, etc., each of which may influence the character of the morbid action in a manner peculiar to itself; or it may be similar to that which might be exercised by another, only causing it to assume a greater or less degree of malignancy, accordingly as the functional operations of the body generally are more or less enervated by it.

This seems to be the way in which a bad habit of body is capable of affecting the maxillary sinus. It is a predisposing, but not an exciting cause of disease; and it is important that this distinction should be borne in mind. The one should never be confounded with the other, because an error of this sort might, in many instances, lead to the adoption of incorrect views concerning the therapeutical indications of the disease. This part of the subject we shall have occasion to advert to hereafter.

Inflammation and ulceration of the nasal pituitary membrane sometimes extend themselves to the maxillary sinus; but disease is not so frequently propagated from the nasal fossæ to this cavity as the intimate relationship between the two might lead one to suppose. It is seldom that both are affected at the same time. Hence, we infer that although lined by one common membrane, the propagation of disease from one to the other is a rare occurrence.

The obliteration of the nasal opening of this cavity is sometimes caused by disease in the nose, and is followed by mucous engorgement of the sinus, inflammation of the lining membrane, distention of the osseous walls, and not unfrequently by other and more complicated forms of disease. But the closing of this opening is oftener an effect than a cause of disease in this cavity, and it generally re-establishes itself without any assistance of art after the cure of the affection which caused it.

If all the circumstances connected with the history of the diseases under consideration could be ascertained, we think it would be found

that these affections are more frequently induced by a morbid condition of the teeth, gums, and alveolar processes than any other cause. There are, in fact, no sources of irritation to which this cavity is so much and so often exposed as those arising from dental organism. It is separated from the apices of the roots of the superior molars and bicuspids by only a very thin plate of bone, and is sometimes even penetrated by them; so that it could scarcely be otherwise than that aggravated and protracted disease in the teeth and alveoli should exert an unhealthy influence upon it. The pain occasioned by diseased teeth is often very severe, sometimes almost excruciating, and inflammation in the alveolo-dental periosteum and gums frequently extends itself to the whole of one side of the face. It would hardly be possible, therefore, for this cavity to escape. Alveolar abscess and sometimes necrosis and exfoliation of the socket of the affected tooth arise from the inflammation thus lighted up. It often happens that the gums and alveolar periosteum are affected for years with chronic inflammation and other morbid conditions.

If, in addition to these facts, other proofs be necessary to establish the agency of dental and alveolar irritation in the production of disease in the maxillary sinus, they may be found. Many of the affections here met with are often cured by the removal of diseased teeth after other remedies have been employed in vain, and that without even perforating the antrum. This would not be the case if the irritation did not arise as a consequence of the dental malady.

Inflammation of the Lining Membrane of the Maxillary Sinus.—Inflammation, when not complicated with any other morbid affection, is the most simple form of disease to which the pituitary membrane of the antrum is subject. As it precedes and accompanies all others, it will be proper to offer a few remarks upon it before entering upon the consideration of those of a more aggravated nature.

Inaccessible as it is here to most of the acrid and irritating agents to which it is exposed in the nasal fossæ and some other cavities of the body, it would rarely become the seat of inflammation were it not for its proximity to the teeth and alveolar border; and simple inflammation rarely gives rise to any other form of diseased action, unless favored by some general morbid tendency, but usually subsides spontaneously on the removal of the exciting cause. In good constitutions it is less subject to inflammation, and consequently to any other description of morbid action, than those in whom there exists some vice of body or constitutional predisposition. Febrile and gastric affections, eruptive diseases, such as measles, smallpox, etc., syphilis, and excessive and protracted use of mercurial medicines, a scorbutic or scrofulous diathesis of the general system—in short, everything that has

a tendency to enervate the vital powers of the body, increases its irritability.

When in a healthy condition it secretes a slightly viscid, transparent, and inodorous fluid, by which it is constantly lubricated ; but inflammation changes the character of the secretion. It causes it to become vitiated ; at first less abundant, it is afterward secreted in larger quantities than usual, becomes more serous, and so acrid as sometimes to irritate the membrane of the nose, over which it passes after having escaped from the antrum. It also exhales an odor more or less offensive, accordingly as the inflammation is mild or severe. It moreover gives rise to a thickening of a membrane, and sometimes to obliteration of the nasal opening. This last rarely occurs, but when it does happen an accumulation of the secretion and other morbid phenomena, of which we shall hereafter treat, result as a necessary consequence.

If at any time during the continuance of the inflammation the patient is attacked with severe constitutional disease, the local affection will be aggravated and sometimes assume a different character.

The inflammation, when long continued, degenerates into a chronic form, and is sometimes kept up for several years without giving rise to any other unpleasant symptoms than occasional paroxysms of dull and seemingly deep-seated pain in the face and a vitiated condition of the fluids of this cavity. The slightly fetid odor which they exhale ceases to be annoying or even perceptible to the patient when he becomes accustomed to it.

Symptoms.—The symptoms of inflammation here, though not always precisely the same as elsewhere, are, for the most part, very similar. They are severe, fixed, and deep-seated pain under the cheek, extending from the alveolar border to the lower part of the orbit; local heat, pulsation, and sometimes fever. Boyer says these symptoms are not always present, and that inflammation may exist when it is not expected. Other affections of the face and superior maxilla may be mistaken for this, and this for others ; but that inflammation should exist without being attended with pain or any other signs indicative of its presence, is scarcely probable.

Deschamps distinguishes the symptoms of this from those of other affections of this cavity by a dull, heavy pain in the region of the sinus, which, he says, becomes sharp and lancinating and extends from the alveolar arch to the frontal sinus. The disease goes on without interruption, increasing until the superior maxilla of the affected side is more or less involved. This malady, he says, cannot be confounded with any other, even where there is no external visible cause ; differing from a simple retention of mucus by being painful at the commencement, and by not being accompanied with swelling of the bones ; from

polypus, by the continuance of pain; and from cancer, by the character of the pain. "Suppuration and ulcers have peculiar signs which cannot be confounded with those of inflammation." Pain in the molar and bicuspid teeth, accompanied by a sense of fluctation in the parts, he seems to regard as a very certain indication of inflammation, and especially when joined to the other symptoms. "If an external cause is discovered, it will furnish a certain diagnosis;" he also mentions fever and headache as almost invariable accompaniments.

The inflammation, if not subdued by appropriate remedies, after having continued for a length of time, gradually assumes a chronic form; the pain then begins to diminish and is less constant; it becomes duller and is principally confined to the region of the antrum. The teeth of the affected side cease to ache, or ache only at times, but still remain sensitive to the touch. The mucous membrane of the nostril next the diseased sinus is often tender and slightly inflamed; and if in the morning, or after two or three hours' sleep, the other nostril be closed by pressing upon it with the thumb or one of the fingers, and a violent expiration be made, a thin, watery fluid of a slightly fetid odor will be discharged, and pain will be experienced in the region of this cavity.

Causes.—All morbid conditions of the teeth and gums, causing irritation in the alveolar periosteal tissue, may be regarded as among the most frequent of its exciting causes, especially caries, necrosis, and exostosis; also loose teeth, and the roots of such as have been either fractured in an attempt at extraction, or by a blow or fall, and left in their sockets, or that have remained after the destruction of their crowns by decay. It sometimes happens, too, that inflammation is excited in this membrane by fractured alveoli; but when an accident of this sort occurs the detached portions of bone are generally soon thrown off by the economy, and, the cause being removed, the inflammation immediately subsides. Not so with the roots of the teeth. They often remain concealed in their sockets for years, unless removed by art. Nature, it is true, makes an effort to expel them from the jaw, but this is accomplished only by a slow and very tedious process, and not, in many instances, until they have given rise to some serious affection. But of the deleterious effects that result from necrosed roots of teeth in the alveoli it is not necessary now to speak; as extraneous bodies, they are always productive of more or less irritation. We might also mention exposure to sudden transitions of temperature and certain constitutional diseases as among the causes which occasionally give rise to inflammation of this membrane.

Treatment.—The curative indications of inflammation of the lining membrane of the antrum are simple, and, for the most part, similar

to those of inflammation in other parts of the body. In many cases great benefit will be derived from the application of leeches to the cheek, as recommended by Mr. Thomas Bell. When the disease is dependent, as in most cases it is, upon an unhealthy condition of the alveolar processes, the first thing to be done is to remove all such teeth or roots of teeth as are productive of the least irritation; for, while any local sources of irritation are permitted to remain, neither topical nor general bleeding, or, indeed, any other treatment, will be of permanent advantage.

Simple inflammation of the lining membrane of the antrum would be of little consequence were it not that it is liable to give rise to other and more dangerous forms of disease, such, for instance, as engorgement or a purulent condition of its secretions. It should never, therefore, be permitted to continue, but be as speedily arrested as possible; and for the accomplishment of this the means here pointed out will, if timely and properly applied, be found fully adequate.

Purulent Condition of the Secretions and Engorgement of the Antrum.—A purulent condition of the secretions of the antrum and mucous engorgement are indiscriminately, though very improperly, denominated by many writers on the affections of this cavity, abscess. To this neither bears the slightest resemblance.

There is no doubt that a purulent condition of the fluids of this cavity is often complicated with ulceration of the lining membrane; but that the affection is different from abscess, its very nature and situation are sufficient to show.

When complicated with ulceration of the mucous membrane—and it is probable that a purulent condition of its secretions, in most instances, is thus complicated—the affection is analogous to ozena, and many of the older writers designate it by that name. Mr. Bell describes it, and very properly, too, as being similar to gonorrhea; both diseases alike consist in an alteration of secretion; in the one case of the pituitary membrane, and in the other of the mucous lining of the urethra; but in neither instance does it possess any of the characteristics of abscess, though the matter in both is purulent.

It has been before stated that the obliteration of the nasal opening was more frequently an effect than a cause of disease in the maxillary sinus; it does, however, sometimes become closed from other causes than an unhealthy condition ,of this cavity; when this happens, engorgement of the sinus is the inevitable consequence. The fluids thus accumulated are not always at first purulent, although they may subsequently become so; when the closing of the opening is the result of previous disease in the antrum, the secretions are more or less altered from the very first.

Accumulation of any secretion within the antrum, whether of mucus or pus, is a source of irritation to the lining membrane, and the pressure which it ultimately exerts upon the surrounding walls causes a new form of diseased action, which not unfrequently involves in disease all the bones of the face as well as those of the base of the cranium. When prevented from escaping through the nasal opening, the secretion eventually makes for itself a way of escape—sometimes through the cheek; at other times beneath it, just above the alveolar ridge; or through the palatine arch or alveoli by the sides of the roots of one or more of the teeth; and from a fistula thus established, fetid matter will be almost constantly discharged. From openings of this sort the matter is sometimes discharged for years, while the disease in the antrum, very frequently, does not seem to undergo any apparent change. At other times the membrane ulcerates and the bony walls become carious.

A purulent secretion from the mucous membrane of this cavity, independently of caries of the bone, or even of simple fistulous openings, is an exceedingly troublesome and unpleasant affection. The odor from the matter is often very annoying, even to the patient, and when the secretions are retained for some days in the sinus before they escape, the fetor is almost insufferable.

In good constitutions the secretions of the antrum are not so liable to become purulent, though they be confined for a long time in the cavity, and thus become more or less offensive. Inflammation of the lining membrane (the immediate or proximate cause) may exist for years without giving rise to it. It is only in scrofulous, scorbutic, or debilitated habits that they are liable to become thus altered. The difference in the effects produced upon them and the surrounding parts by inflammation, is owing to the difference in the state of the constitutional health of those affected with it.

Where a puriform state of the secretions is complicated with ulceration of the membrane, the matter will have mixed with it a greater or less quantity of flocculi, sometimes of so firm a consistence as to block up the nasal opening and prevent its exit. Mr. Thomas Bell says he has seen more than one case in which a considerable accumulation had taken place in the antrum, accompanied by the usual indication of this affection (muco-purulent engorgement of the sinus), when a sudden discharge of the contents into the nose took place, "in consequence of the pressure having overcome the resistance which had thus been offered to its escape." Cases of a very similar nature have fallen under our observation, the history of one of which will be given in the course of this chapter. The formation of these flocculi rarely ceases, except with the cure of the ulcers on the membrane. They give rise to considerable irritation, and their presence always

constitutes an obstacle to the cure. They are usually removed by injections.

The pituitary membrane of the antrum, when in a healthy state, secretes, as we have before stated, a transparent, slightly viscid, and inodorous fluid, poured out only in sufficient quantity to lubricate the cavity. But when inflammation is excited in the membrane, its secretions soon become more abundant, and are at first thinner, afterward thicker and more glutinous. Their color and consistence are not always the same: instead of being transparent, they sometimes have a dirty, opaque appearance; at other times they assume a greenish, whitish, or yellowish color, and in some instances they bear a considerable resemblance to pus, which, it has been conjectured, might be owing to suppuration of some of the mucous follicles and a mixture of pus with its secretions. Mr. Thomas Bell, however, inclines to the opinion that it is attributable to an "alteration simply" of the secretions of the cavity. Their color and consistence are determined by the degree of inflammation; the length of time it has existed; the state of the health of the lining membrane, and that of the surrounding osseous walls; the egress which the matter has from the sinus; and the general habit of the body.

Affections of this sort are more common to young subjects than to middle-aged or persons in advanced life. An eminent French writer says that of three individuals affected with dropsy (mucous engorgement), the oldest was not twenty years of age.

Symptoms.—The diagnoses of the several affections of the antrum are so much alike, that it is often difficult to distinguish those that belong to one from those attendant upon another. The symptoms of mucous engorgement and purulent accumulation, however, are generally such as will enable the practitioner to distinguish, with considerable certainty, these from other affections. They are always preceded by inflammation of the lining membrane; a description of the symptoms of which, having already been given, need not be repeated. Omitting these, we at once proceed to mention those by which they are accompanied.

In speaking of the symptoms more particularly belonging to a purulent condition of the secretions of the antrum, Deschamps says the affection may be distinguished by dull, heavy pain, extending along the alveolar border. Upon this symptom alone little reliance can be placed, as it is always present in chronic inflammation. In addition to this he mentions the presence of decayed teeth; soreness in those that are sound; and, on the patient's inclining his head to the side opposite to the one affected, the discharge of fetid matter from the nose. These are very conclusive indications of purulent

effusions in this cavity. Bordenave, after enumerating the symptoms indicative of inflammation, mentions the following as belonging to the affection of which we are now speaking : dull and constant pain in the sinus, extending from the maxillary fossæ to the orbit ; a discharge of fetid matter from the nose, when the patient inclines his head to the opposite side, or when the nose is blown from the nostril of the affected side. These symptoms are mentioned by almost every writer upon the subject, as indicative of a purulent condition of the secretions of the maxillary sinus.

The symptoms of engorgement differ materially from those which denote simply a purulent condition of the mucous secretions. The pain, instead of being dull and heavy, as just described, becomes acute, and a distressing sense of fullness and weight is felt in the cheek, accompanied by redness and tumefaction of the integument covering the antrum. The nasal opening having become closed, the fluids of the cavity gradually accumulate until they fill it ; when, finding no egress, they press upon and distend the surrounding osseous walls, causing those parts which are the thinnest ultimately to give way. The effects are generally first observable anteriorly beneath the malar prominence, where a smooth, hard tumor presents itself, covered with the mucous membrane of the mouth. But this is not always the point which first gives way ; the sinus sometimes bursts into the orbit, at other times outwardly through the cheek, or through the palatine arch. The long-continued pressure thus exerted upon the bony walls often causes the breaking down or softening of their tissues.

The tumor, which is at first hard, becomes in a short time so soft as readily to yield to pressure. A distention, Deschamps says, may be distinguished from other diseases that affect the skin or subcutaneous tissues by the uniformity or regularity of the tumor, its firmness at the commencement, the slowness with which it progresses, and, above all, by the natural appearance of the skin, and the absence of pain when pressure is made upon the tumor. Obliteration of the nasal opening, he says, may be suspected by the dryness of the nostril of the affected side, the mucous membrane of which becomes thickened and the cavity contracted, inflammation and sponginess of the gums, loosening and, sometimes, in consequence of the destruction of their sockets, displacement of the teeth, may also be mentioned as occasional accompaniments of engorgement.

Causes.—Inflammation of the mucous membrane is the cause of a purulent condition of the secretions of the maxillary sinus, and this arises more frequently from peridental irritation than from any particular habit of body or constitutional disturbance. Engorgement results from the obliteration of the nasal opening, which, in the case of

altered secretion, is usually caused by inflammation and thickening of the lining membrane.

Treatment.—The curative indications of muco-purulent secretion and engorgement of the maxillary sinus are, firstly, if the nasal opening be closed, the evacuation of the retained matter; secondly, the removal of all local and exciting causes of irritation; thirdly, and lastly, the restoration of the lining membrane to its normal function.

For the fulfillment of the first an opening must be made into the antrum, and this should be effected in that part which will afford the most easy exit to the retained matter. Several ways have been proposed for the accomplishment of this object; and before we proceed further, it may not be amiss to notice some of the various methods that have been adopted by different practitioners.

With regard to the tooth most proper to be extracted, authors differ. Cheselden preferred the first or second molar. Junker recommended the extraction of the first or second bicuspid, and if a fistula had formed, to enlarge it instead of perforating the floor of the antrum. But the second molar, being directly beneath the most dependent part of the cavity, is the most suitable tooth to be removed. If this be sound, the first or third molar, or either of the bicuspids, if carious, may be extracted in its stead, and, in fact, no tooth beneath the antrum in an unhealthy condition should be permitted to remain. Heath recommends the extraction of the first molar on account of the depth of its socket, and because it is more liable to decay than any of the other teeth.

An opening having been effected through the palatine cavity of a molar tooth into the antrum, it should be kept open until the health of the cavity is restored. For this purpose, a sound, bougie, or cannula adapted to the purpose may be introduced.

When the natural opening is closed, the first indication, as has been stated, is the evacuation of the matter; and for this purpose a perforation should be made into the sinus, and the most proper place for effecting this, it has been shown, is through the alveolar cavity of the second molar. It may, however, be penetrated from that of either of the other molars or bicuspids.

The perforation, after the extraction of the tooth, is made with a straight trocar, which will be found more convenient than those usually employed for the purpose. The point of the instrument, having been introduced into the alveolus through which it is intended to make the opening, should be pressed against the bottom of the cavity in the direction toward the center of the antrum. A few rotary motions of the instrument will suffice to pierce the intervening plate of bone.

Fig. 608 represents trephines for opening the antrum, either through the palatine cavity of a second or first molar, or through the alveolus between these two teeth.

If the first opening be not sufficiently large, its dimensions may be increased to the necessary size by means of a spear-pointed instrument. The entrance is usually attended with a momentary severe pain, and the withdrawal of the instrument followed by a sudden gush of fetid mucus. In introducing the trocar, care should be taken to prevent a too sudden entrance of the instrument into the cavity. Without this precaution it might be suddenly forced against the opposite wall. It is not always necessary to perforate the floor of the antrum after the extraction of the tooth; it occasionally happens, as has already been remarked, that some of the alveolar cavities communicate with it.

An opening having thus been effected, it should be prevented from closing until a healthy action is established in the lining membrane, and for this purpose a bougie, or leaden or silver cannula, or, still better, a small metal plate, fitted by impression and dies to the portion of the ridge about the opening, with a small tube attached to fill the aperture, to facilitate the flow of matter, and for syringing, and as preventive of the premature closure of the opening, may be inserted and secured to one of the adjacent teeth. It should, however, be removed for the evacuation of the secretions at least twice a day. The formation of an opening at the base or most dependent part of the sinus will, in those cases where a fistula has been previously formed, be followed in most instances by speedy restoration. Having proceeded thus far, the cure will be aided by the employment of such general remedies as may be indicated by the state of the general health; and for the dispersion of the local inflammation, leeches to the gums and cheeks will be found serviceable. The antrum may, in the meantime, be injected with, at first, some mild or bland fluid, and afterward with gently stimulating liquids. Diluted port wine, weak solutions of the sulphate of zinc and rose-water, sulphate of copper and rose-water, or permanganate of potash, answer admirably, especially the latter, in the proportion of two grains to the ounce of water. Diluted tincture of myrrh may sometimes be advantageously employed, and when the membrane is ulcerated, a solution of nitrate of silver will be highly serviceable. The author has used a solution of iodid of potassium with advantage, also a weak alcoholic solution of tannic acid and diluted tincture of iodin. After the use of the permanganate of potash, a carbolic solution, ʒj to water, ℥viij, or the antiseptic preparation, listerine, may

FIG. 608.

be used as an injection with decided benefit. The injection of a warm solution of salt and water is highly recommended as a preparatory step before making use of the permanganate of potash and the carbolic solution. For correcting the fetor of the secretions, a weak solution of chlorinated soda or lime, or a solution of permanganate of potash may be occasionally injected into the antrum.

In cases of simple muco-purulent secretion, a weak decoction of galls may be injected into the sinus with advantage. Injections of a too stimulating nature are sometimes employed. This should be carefully guarded against by making them at first weak, and afterward increasing their strength as occasion may require; and if symptoms of a violent character are by this means produced, they should be combated by applying leeches to the gums and fomentations to the cheek.

Dependent as these affections in most instances are upon local irritants, greater reliance is to be placed upon their removal and giving vent to the acrid puriform fluids, than on any therapeutical effects exerted upon the cavity by injections. As adjuvants they are serviceable, but cure cannot be effected while the exciting cause remains unremoved.

Dr. Frank Abbott recommends a thorough washing out of the antrum, immediately after an opening is made into it, with a warm solution consisting of a teaspoonful of salt to half a pint of water, injected with slight force, and if there is still an offensive odor, to syringe with the permanganate of potash solution; then with the carbolic solution or with listerine; and as a dressing, to be renewed daily, carbolized oil (1 part of carbolic acid to 15 parts of oil of sweet almonds) on cotton, so applied that it may be retained in the antrum, and secured by attaching it to a tooth or to a plate worn in the mouth. If no improvement is apparent after two or three days, the antrum is to be syringed with a solution consisting of one dram of carbolic acid, 1 ounce of tincture of iodin, and 8 ounces of water; and in some cases with a more powerful stimulant, such as 10 grains of chlorid of zinc to 1 ounce of water. For systemic treatment he recommends sulphid of calcium, one-tenth of a grain pill three times a day after meals, doubling the dose if necessary.

Epithelioma of the antrum is a malignant form of tumor which fills this cavity, destroying the walls and also the hard palate. A cancerous, mushroom-like formation sometimes attaches itself to the roof of the mouth. It may involve much surface before its true character is discovered, and it is very difficult to remove. In some cases the jaw must be removed, while in others, especially if the character of the disease is easily determined, a free opening must be made and the can-

cerous tissue scraped away, followed by repeated applications of chlorid of zinc or other strong escharotics.

For other tumors, etc., of the antrum, the reader is referred to "Tumors of the Mouth."

CHAPTER X.

CARIES OF THE MAXILLARY BONES.

Caries of the maxillæ, like necrosis, is not a very common disease, and differs from the latter in being analogous to ulceration in the soft parts, and in being free from the odor, when cleanliness is observed, which characterizes necrosis.

The symptoms of caries of bone resemble those of alveolar abscess, and when the acute form of the disease is present it is associated with inflammation of the gums and peridental membrane; periodontitis being early manifested when the carious condition of the bone results from diseased teeth. When caries of the maxillæ is well established, one or more fistulous openings exist in the gum or in some adjacent part; these openings being surrounded, in the majority of cases, by fungous granulations. The bone beneath is full of minute cells, and is of a soft consistence—a condition readily detected by the probe or an excavator, and differing very materially from the solid, resisting structure presented by bone when in a normal condition. Commencing like ordinary periostitis, there is present, in the early stage, increased vascularity and congestion, which terminates in ulceration; the bone cells becoming enlarged by the breaking down of their walls, and filled with semi-organized lymph, the accumulation of which is attended with a rapid advance of the destructive process. The numerous irregular cavities existing in the bone are lined by a glazed secreting surface. According to Virchow, "the bone breaks up in its territories, the individual corpuscles undergo new developmental changes (granulation and suppuration), and remnants composed of the oldest basis substance remain in the form of small, thin shreds in the midst of the soft substance. In ossification (in cartilage) there is a portion of the original intercellular substance of the cartilage cells (secondary cells), which, though it belongs to the group as a whole, yet, when these, in the course of ossification, are transformed into a number of isolated bone cells, becomes, comparatively speaking, almost entirely independent of those cells individually, and therefore escapes the changes which befall them."

It is this portion which remains behind the caries, while the secondary intercellular substance perishes. "At the moment a periosteal tissue quits the surface of a bone, and the vessels are drawn out from the cortex in inflammatory condition, we see, not as in normal bone, mere threads, but little plugs, thicker masses of substance; and if they have been entirely drawn out, there remains a disproportionately large hole, much more extensive than it would be under normal circumstances. On examining one of these plugs you will find that around the vessel a certain quantity of soft tissue lies—the cellular elements of which are in a state of fatty degeneration. At the spot where the vessel has been drawn out the surface does not appear even, as in normal bone, but rough and porous; and when placed under the microscope you remark those excavations, those peculiar holes, which correspond to the liquefying bone territories. If it be asked, therefore, in what way bone becomes porous in the early stage of caries, it may be said that the porosity is certainly not due to the formation of exudations, seeing that for these there is no room, inasmuch as the vessels within the medullary canals are in immediate contact with the osseous tissue. On the contrary, the substance of the bone in the cellular territories liquefies; vacuities form, which are first filled with a soft substance composed of a slightly streaky connective tissue, with fatty degenerated cells. The whole process is a degenerative ostitis, in which the osseous tissue changes its structure, loses its chemical and morphological character, and so becomes a soft tissue, which no longer contains lime."

Causes.—In the early stages of caries of the maxillæ, there is nothing to distinguish it from periodontitis; and although the causes of this disease are various, yet one of the most common is the presence of dead teeth and roots of teeth, and the superior maxilla is much more prone to its attacks than the inferior, and especially where the bone is of a loose, spongy character, as in the strumous and mercurial diathesis. In cases of ulceration and extensive destruction of the tissues of the face, resulting from syphilis or lupus, the maxillary bones may become carious, and terrible deformity follow, as in cases where it commences in the palate, and, destroying it, makes a common cavity of the mouth and nose and involves the face.

Treatment.—In the early stage of the acute form of caries of the bones of the jaws, such antiphlogistic remedies as cathartics, diaphoretics, hot foot baths, leeches, and counter-irritants may be resorted to. If a diseased tooth or teeth give rise to the inflammation, such should be removed if they cannot be successfully treated. Blood taken from the arm, and also dry cups, are often serviceable. If a depraved condition of the system is present, as is frequently the case, the disease

being of an asthenic type, such constitutional remedies as iron, quinin, cod-liver oil, and like tonics are indicated; and when the caries is established, injections of aromatic sulphuric acid in full strength, or the official sulphuric acid, one part to six or eight parts of water, or, when required, in equal parts, will dissolve the carious bone, relieve the irritation caused by its presence, and hasten the cure, having a stimulant effect upon diseased tissues, and exerting an antiseptic influence. Listerine may also be employed for its antiseptic properties in conjunction with the aromatic sulphuric acid, no other remedy proving so satisfactory in the treatment of this disease as the latter agent. Other agents in the form of injections have also been recommended, such as carbolic acid solution, tincture of iodin, compound tincture of capsicum, and chlorid of zinc.

The removal of the carious bone is often necessary by such appliances as rose-head drills, made for the purpose and operated by the dental engine, chisels, etc.

An incision is first made to expose the bone, and the carious portion is then cut away with the rose-head drill or chisel, causing but little pain, until normal structure is reached, which is easily distinguished by the difference in touch of the instrument. Comparatively slight hemorrhage occurs, as a general rule, and it is readily controlled by such styptics as a saturated solution of chlorid of zinc, Monsel's powder, or compression by means of hot sponges. In employing injections in the treatment of well-established caries of bone, great benefit results from the preparatory cleansing of the parts with warm water, and its use should never be omitted.

PART FOURTH.

MECHANICS.—DENTAL PROSTHESIS.

MECHANICS.

THIS branch of dental science teaches the art of replacing lost organs of the Mouth, or any lost parts thereof. It is now generally called Dental Prosthesis (replacement). Mechanical detail is its prevailing feature; substitution or replacement is its distinctive peculiarity.

Mechanical detail also distinguishes the Surgery of dentistry as compared with general surgery; but as a branch of dentistry, therapeusis, or the arrest of disease, is its distinctive peculiarity.

The one treats disease or irregularity of the natural organs; the other substitutes their loss by artificial ones. Both demand a skillful training of the hands, and equally require, for their fullest development, all the knowledge comprehended under the term Dental Science.

Dental Prosthesis includes the laws and principles which determine and regulate the processes employed in the construction of all forms of dental mechanism; also the properties and relations of all materials used in these processes. It gives rules for the replacement of—

1. Lost teeth.
2. Lost alveoli, or parts thereof.
3. Lost palate, hard and soft, or parts thereof.

The first division is the most important, because the most universally demanded.

The following is the order of operations in the REPLACEMENT OF LOST TEETH and classification of the various styles of work:—

1. Preparation of the mouth; including
   (*a*) Treatment of the mucous membrane.
   (*b*) Extraction or treatment of teeth and roots.
2. Impression of the mouth; including
   (*a*) Form and material of impression cups.
   (*b*) Description of impression materials.
   (*c*) Selection and manipulation of the same.
   (*d*) Preparation for the model.
3. The plaster model; including
   (*a*) General directions for making model.
   (*b*) Special forms adapted to subsequent uses.
   (*c*) Removal from impression.
   (*d*) Preparation for the operation of making the plate.

4. The base-plate; which is either
   (*a*) Permanent, in swaged work, or
   (*b*) Temporary, in plastic work.

The subsequent operations differ in their order and character so widely as to require a separate classification in

(A) Swaged work :—
  (1) Metallic die and counter-die, made by
    (*a*) Sand molding;
    (*b*) Dipping, or pouring;
    (*c*) Fusible metal process, or by
    (*d*) Pouring directly into the impression.
  (2) Refining and rolling plate.
  (3) Swaging plate (gold, silver, platinum, or aluminum).
  (4) Articulating impressions.
  (5) Adjustment on articulator.
  (6) Selection and fitting of teeth, and
  (7) Attaching them to base-plate, by
    (*a*) Soldering;
    (*b*) Vulcanite; Celluloid;
    (*c*) Porcelain continuous gum.
  (8) Finishing process.

(B) Plastic work :—
  (1) Temporary plate of
    (*a*) Wax, or gutta-percha;
    (*b*) Thick tin, or lead, foil.
  (2) Articulating impressions.
  (3) Adjustment on articulator.
  (4) Selection and fitting of teeth.
  (5) Preparation of the matrix.
  (6) Molding and hardening of the base-plate, made of
    (*a*) Vulcanite compounds, which harden by heat;
    (*b*) Celluloid compounds, which harden by heat;
    (*c*) Molten tin and other alloys, which harden on cooling;
    (*d*) Molten and swaged aluminum;
  (7) Which process at the same time attaches the teeth.
  (8) Finishing process.

The details of Swaged work vary according to the mode of making dies, the metal chosen for the plate, and the manner of attaching the teeth; but the order of operations is the same. The details of Plastic work vary also, according to the material composing the plate; but the order of operations is the same—differing from the former mainly because articulation follows the formation of the base-plate in one case, while in the other it precedes it.

These differences in the material of the base-plate give rise to a classification of Swaged work into

1. Gold plate;
2. Aluminum plate;
3. Platinum plate.

The first (and third) allows attachment of the teeth by soldering; the second demands a vulcanite attachment; the third alone permits, by virtue of its resistance to furnace heat, the addition of a continuous porcelain gum.

Plastic work is divided into.

1. Vulcano-plastic;
2. Cellulo-plastic;
3. Metallo-plastic;
4. Ceramo-plastic;

The first is known as rubber work; the second is known as celluloid work; the third includes cheoplastic work, the old-fashioned block-tin base, all tin alloys and cast aluminum, etc.; the fourth is known as the porcelain base.

In Prosthetic dentistry, swaged work is the patrician element; plastic work the plebeian. When the latter runs riot, without the conservative influence of the former, the power of the people becomes a power for evil. This is precisely the danger which now threatens dentistry, in the abuse of certain most valuable processes and materials.

Facility of construction and cheapness of material have encouraged a style of practice in the highest degree detrimental to the profession. If such practice is inseparable from plastic work, it should be unhesitatingly abandoned by every one who holds the honor of dentistry dear to him. It becomes, also, a grave question how far the present mania for patents (another abuse of a valuable privilege) is beneficial to the reputation of a liberal profession.

CHAPTER I.

DENTAL PROSTHESIS.

Contributing, as the teeth do, to the beauty and expression of the countenance, to correct enunciation, and, through improved facility of mastication, to the health of the whole organism, it is not surprising that their loss should be considered a serious affliction, and that art should be called upon to replace such loss with artificial substitutes.

So great, indeed, is the liability of the human teeth to decay, and so much neglected are the means of their preservation, that few persons at the present day reach even adult age without losing one or more of these invaluable organs. Happily for suffering humanity, they can now be replaced with artificial substitutes so closely resembling the natural organs as to be readily mistaken for them, even by critical and practiced observers. Although there is a perfection in the work of nature that can never be equaled by art, artificial teeth are now so constructed as to subserve, at least to a great extent, the purposes of the natural organs. When properly adjusted, they are worn without the slightest discomfort; so much so, in many cases, that the patient, after they have been in the mouth a few weeks, is scarcely conscious of their presence.

The construction of artificial teeth is an operation which, though acknowledged to be of great importance, and performed by every one having any pretension to a knowledge of dentistry, is, unfortunately, but little understood by the majority of practitioners. The mouth is often irreparably injured by their improper application. A single artificial tooth, badly inserted, may cause the destruction of the two adjacent natural teeth or those to which the artificial appliance is secured; and if the deficiency thus occasioned be unskillfully supplied it may cause the loss of others; in this way all the teeth of the upper jaw are sometimes destroyed.

The utility of artificial teeth depends upon their proper construction and correct application. There is no branch of dental practice that requires more skill and judgment or more extensive and varied scientific information. A knowledge of the anatomy and physiology of the mouth, of its various pathological conditions and their therapeutical indications, is as essential to the mechanical as to the surgical dentist. To correct information upon these subjects must be added the ability to execute, with the nicest skill and most perfect accuracy, all the mechanism required in dental prosthesis.

There are difficulties connected with the insertion of artificial teeth of which none but an experienced dentist has any idea. They must be constructed and applied in such a manner that they may be easily removed and replaced by the patient, if upon a base; at the same time they must be securely fixed in the mouth and be productive of no injury to the parts with which they are in relation.

But perfect mechanism is not the sole element of success; often it is not the most essential one. To know when to extract and when to retain a root or a tooth; when to secure a piece by clasps and when by simple adaptation; when to use gold and when some other material; to determine the best form of a plate and the proper time for its

insertion; finally, to determine when and what prosthetic skill can do, when and why it will fail—are a few of the problems in dental mechanics which demand for their correct solution a fullness and extent of information which are not always brought to bear, perhaps because, unfortunately, the necessity is not recognized as it should be.

Notwithstanding the triumphs of prosthetic dentistry and the high state of excellence to which it has arrived, at no previous time was there ever so much injury inflicted and suffering occasioned by artificial teeth as at present, resulting solely from their bad construction and incorrect application. That such should be the case when there are so many scientific and skillful dentists in every city and in many of the villages of the country may seem strange, but the fact is nevertheless undeniable. We may explain it in part by the very rapidly increasing demand for dental services, which has not allowed time for the development of intelligent and skilled labor, either of head or hand; in part, also, by the universal experience that all new professions are full of immature and crude material. But these explanations cannot long be received in excuse for a state of things which ought to be rapidly disappearing—which is, in fact, giving way under the combined influence of our colleges, our periodicals, and text-books, the teachings and example of our eminent practitioners, and the more appreciative judgment of the public.

These remarks apply alike to the surgery and mechanism of dentistry. The latter has an additional barrier to progress in the common practice of delegating the greater part of its details to inexperienced, uninformed, and irresponsible assistants. Perfect dentistry demands equal skill and education in both departments. Each requires that its complete series of operations shall be the work of one person. If, therefore, the work of the two are so far incompatible that they cannot be combined, the separation should be complete. The semi-mechanism of the surgeon is like the semi-surgery of the mechanism. Each injures an otherwise perfect reputation; both do harm to the profession they seek to honor.

In an excellent article on "Temperament in Relation to the Teeth," in the *Dental Cosmos*, Dr. James W. White writes as follows:—

"The value of a practical application of the study of temperament in the practice of dentistry is apparent. That the relation of the teeth to temperament is, as a rule, ignored by those engaged in prosthetic dentistry is evident in the mouths of a majority of those who are so unfortunate as to be under the necessity of wearing substitutes for lost natural dentures.

"A certain law of harmony in nature between the teeth and other physical characteristics necessitates respect to size, shape, color, and other qualities in an artificial denture, in order that it shall correspond

with other indications of temperament; and if teeth correlated in their characteristics to those which nature assigns to one temperament be inserted in the mouth of one whose physical organization demands a different type, the effect is abhorrent. The artificiality of artificial teeth is the subject of remark by those who have little or no conception of the reason therefor—simply an instinctive appreciation of the incongruity and unreality. It is, indeed, rare to see a case in which there is occasion for a moment's hesitation as to the fact of replacement. There is no dental service that, from the esthetic standpoint, is, as a rule, so ill performed as the prosthetic. Thousands of dentures are constructed which serve the needs of the wearer for speech and mastication, but which are nevertheless deserving of utter condemnation as art productions. More attention has been paid to the best methods of restoring impaired function—securing comfort and usefulness in artificial dentures—than to a correlation of the substitutes to the physical characteristics of the patient.

"What is needed is such an appreciation of the law of correspondence that the dentist can cipher out, as by the rule of three, the character of teeth required in the case of an edentulous mouth, with the same precision as the comparative anatomist can from a single bone indicate the anatomical structure of the animal to which it belonged."

The following illustrations and descriptions of the teeth as indicated by temperament are interesting and instructive:—

General Divisions.	Bilious.	General Divisions.	Sanguineous.
General color and quality of color.	Bronze-yellow, with strength or power of coloring.	General color and quality of color.	Cream-yellow, and inclined to translucency.
General form.	Large and inclined to angular; rather long in proportion to breadth.	General form.	Well proportioned; abounding in curved or rounded outlines; cusps rounding.
Surfaces of the teeth.	Inclined to transverse ridges and abounding in strong lines; neither brilliancy nor transparency of surface, but slight translucency.	Surfaces of the teeth.	Smooth, or nearly so; elevations and depressions rounded; cutting-edges and cusps translucent. Fair degree of brilliancy.
Articulation.	Firm and close; well locked.	Articulation.	Moderately firm; jaw inclined to rotate in mastication.
Gum margin or festoon.	Heavy and firm, but inclined to angularity.	Gum margin or festoon.	Round and full, as regards both breadth and depth.
Rugæ.	Heavy and rugged in shape; squarely set.	Rugæ.	Numerous and graceful in outline; not heavy, but well rounded.

FIG. 609.—BILIOUS.

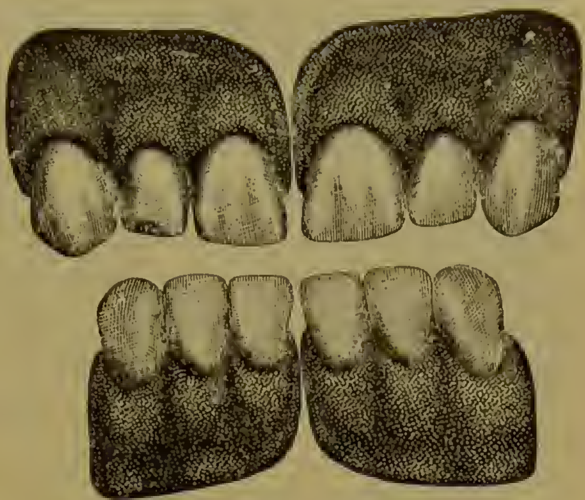


FIG. 610.—SANGUINEOUS.

FIG. 611.—NERVOUS.

FIG. 612.—LYMPHATIC.

GENERAL DIVISIONS.	NERVOUS.	GENERAL DIVISIONS.	LYMPHATIC.
General color and quality of color.	Pearl-blue or gray; inclined to transparency.	General color and quality of color.	Pallid and opaque, or muddy in coloring.
General form.	Length predominating over breadth; fine, long cutting-edges and cusps.	General form.	Large, but not shapely; breadth predominating over length; cusps poorly defined.
Surfaces of the teeth.	Brilliant and transparent depressions and elevations; abounding in long curves.	Surfaces of the teeth.	Surfaces of incisors devoid of depressions or elevations; opaque and dead in finish, even to cutting-edges.
Articulation.	Very long and penetrating.	Articulation.	Loose and flat.
Gum margin or festoon.	Delicate, shapely, and fine; oval in curve.	Gum margin or festoon.	Thick and undefined in shape.
Rugæ.	Close, not numerous; small and long.	Rugæ.	Sparse and flat.

We shall enumerate some of the different kinds of dental substitutes that have been employed since the commencement of the present century. We shall also notice briefly the principal methods that have been adopted in their application, before entering upon a minute description of those practiced at the present time. Great improvements have been made in dental prosthesis since the publication of the former editions of this work. In fact, no science or art, except chemistry, has been so eminently progressive during the last thirty years as mechanical dentistry.

CHAPTER II.

SUBSTANCES EMPLOYED AS DENTAL SUBSTITUTES

THERE are two qualities which it is highly important that dental substitutes should possess. They should be durable in their nature, and in their appearance should resemble the natural organs which they replace or with which they are associated.

The kinds of teeth that have been employed since 1820 are—

1. Human teeth.
2. Teeth of neat cattle, sheep, etc.
3. Teeth carved from the ivory of the elephant's tusk and from the tooth of the hippopotamus.
4. Porcelain teeth.

HUMAN TEETH.

As regards appearance only, which in a dental substitute is an important consideration, human teeth are preferable to any other, except, perhaps, the almost perfect recent productions of the dento-ceramic art. When formerly used for this purpose they were of the same class as those the loss of which they were to replace. The crowns only were employed, and if well selected and skillfully adjusted the artificial connection with the alveolar ridge could not easily be detected.

The durability of these teeth when thus employed depends upon the density of their texture, the soundness of their enamel, and the condition of the mouth in which they are placed. If they are of a dense texture, with sound and perfect enamel, and are placed in a healthy mouth, they may last from eight to twelve years, or even longer. The difficulty, however, of procuring these teeth was generally so great that it was seldom that such as we have described could be obtained; and even when it was possible the mouth, in half the cases in which such teeth were placed, was not in a healthy condition; its secretions often

so vitiated and of so corrosive a nature as to destroy them in less than four years. We have even known them to be destroyed in two, and in one case in fifteen months.

A human tooth artificially applied is more liable to decay than one of equal density having a vital connection with the general system, for the reason that its dentinal structure is more exposed to the action of deleterious chemical agents. Yet of all the *animal substances* employed for this purpose human teeth are unquestionably the best. They are harder than bone, and being more perfectly protected by enamel, are consequently more capable of resisting the action of corrosive agents.

Many object to having human teeth placed in the mouth, under the belief that infectious diseases may be communicated by them. But the purifying process to which they are previously submitted greatly diminishes this danger. When the practice of transplanting teeth was in vogue occurrences of this sort were not unfrequent, but since that has been discontinued these have seldom, if ever, happened. Still, the prejudice against human teeth is so strong that it is impossible, in most cases, to overcome it. This feeling, the difficulty of procuring them, the high price they command, and their want of durability, have gradually led to their entire disuse, which is scarcely to be regretted, now that art can produce in porcelain such accurate imitations of nature. The only case in which we might feel called upon to insert natural teeth is where any of the twelve front teeth become loosened by periosteal disease and drop from their sockets while yet perfectly free from caries. These teeth may often be adjusted to a plate so as to present an exceedingly natural appearance.

TEETH OF CATTLE.

Of the various kinds of natural teeth employed for dental substitutes, those of neat cattle are, perhaps, after human teeth, the best. By slightly altering their shape they may be made to resemble the incisors of some persons; but a configuration similar to the cuspids cannot be given to them, and in most cases they are too white and glossy. The contrast, therefore, which they form with the natural organs should constitute, were they in all other respects suitable, a very serious objection to their use. Imitation of nature has been too much disregarded, both by dentists and patients. Indeed, many of those who need artificial teeth wish to have them as white and brilliant as possible, and some practitioners lack either the decision or the judgment to refuse compliance with a practice which destroys all that beauty and fitness which it is the aim of dental esthetics to cultivate.

There are other objections to the use of these teeth. In the first

place, they are only covered anteriorly with enamel; in the second, their dentinal structure is less dense than that of human teeth, and, consequently, they are more easily acted on by chemical agents. They are, therefore, less durable, seldom lasting more than from two to four years. Another objection to their use is, they can be employed in only the very few cases where short teeth are required, owing to the large size of their nerve cavities. It is seldom, therefore, that they can be advantageously used as substitutes for human teeth.

IVORY OF THE ELEPHANT AND HIPPOPOTAMUS.

Artificial teeth made from the ivory of the tusk, both of the elephant and the hippopotamus, have been sanctioned by usage from the earliest periods of the existence of this branch of the art. We must not hence conclude that it has been approved by experience; on the contrary, of all the substances that have been used for this purpose this is certainly the most objectionable.

The ivory of the elephant's tusk is decidedly more permeable than that obtained from the hippopotamus. So readily does it absorb the buccal fluids that, in three or four hours after being placed in the mouth, it becomes completely saturated with them. Consequently, it is not only liable to chemical changes, but the absorbed secretions undergo decomposition; and when several such teeth are worn, they affect the breath to such a degree as to render it exceedingly offensive. Again, on account of its softness, teeth are easily shaped from it; but, not being covered with enamel, they soon become dark, and give to the mouth a repulsive appearance. Fortunately, however, in the United States elephant's ivory is rarely used, either as a base-plate or for the teeth themselves.

The ivory of the tusk of the hippopotamus is much firmer in its texture than that obtained from the elephant; being covered with a hard, thick enamel, teeth may be cut from it which, at first, very closely resemble the natural organs. There is, however, a peculiar *animation* about human teeth, which those made from this substance do not possess; moreover, they soon change their color, assuming first a yellow, and then a dingy bluish hue. They are, also, like elephant ivory, very liable to decay. We have in our possession a number of blocks of this sort, some of which are nearly half destroyed. The same objection lies against teeth made from the hippopotamus ivory, sufficient to condemn its use. Like those formed from elephant ivory, they give to the breath an offensive odor, which no amount of care or cleanliness can wholly correct or prevent.

PORCELAIN OR INCORRUPTIBLE TEETH.

The manufacture of porcelain teeth did not for a long time promise to be of much advantage to dentistry. But through the ingenuity and indefatigable exertions of a few, they have, within the last thirty years, been brought to such perfection as to supersede all other kinds of artificial teeth.

The French, with whom the invention of these teeth originated, encouraged their manufacture by favorable notices; and the rewards offered by some of the learned and scientific societies of Paris contributed much to bring it to perfection. They were still, however, deficient in so many particulars that they received the approbation of very few of the profession, and then only in some special cases. It is principally to American dentists that we are indebted for that which the French so long labored in vain to accomplish.

A want of resemblance to the natural organs in color, translucency, and animation was the great objection urged against porcelain teeth; and, had not this been obviated, it would have constituted an insuperable objection to their use. Until 1833 all that were manufactured had a dead, opaque appearance, which rendered them easy of detection when placed beside the natural teeth, and gave to the mouth an unnatural aspect. But so great have been the improvements in their manufacture that few can now distinguish betwen the natural teeth and their artificial companions, if well selected and skillfully applied.

The advantages which mineral teeth possess over every sort of animal substance are numerous. They can be more readily secured to the plate and are worn with greater convenience. They do not absorb the secretion, and, consequently, when proper attention is paid to their cleanliness they do not contaminate the breath or become in any way offensive. Their color never changes. They are not acted on by the chemical agents found in the mouth, and hence the name *incorruptible*, which has been given them.

Porcelain teeth are divided into single, sectional, carved-block, continuous gum, pivot-crown teeth, and porcelain facings, all of which consist of a body and enamel.

The body or base is composed of silex, feldspar, and kaolin, while the enamel is principally composed of feldspar, and is colored by means of metals in a state of minute division, or in the form of oxids. The principal metals employed for this purpose, and which give the positive tints, are gold, platinum, and titanium. Gold, in a state of fine division, imparts a rose-red tint; the same metal, in the form of an oxid, gives a bright rose-red tint. Platinum, in the form of sponge and filings, imparts a grayish-blue tint. Titanium, in the form of an

oxid, imparts a bright yellow tint. Other metals, in the form of oxids, are also employed to color porcelain teeth, such as uranium, which gives a greenish-yellow tint; manganese, a purple tint; cobalt, a bright blue tint; silver, a lemon-yellow tint; zinc, also a lemon-yellow tint; and purple of Cassius, a rose-purplish tint. By combining the tints, using some to soften others, the different shades of color required to impart character and a life-like appearance to artificial teeth are obtained.

The vast extension of mechanical practice is due, more than to any other one cause, to these improvements in the manufacture of porcelain teeth—improvements essentially American, and so important as fairly to justify a little of that boasting spirit which, transplanted from the mother country, has attained such luxuriant growth on American soil.

The beautiful exact imitation of the varying shades of the natural gum, which as yet has been found possible only in porcelain, would of itself give to this material a claim over every other. All attempts to color ivory have failed to produce any permanent results. More recent experiments in the several vulcanizable materials have thus far given opaque and lifeless colors, which no stretch of imagination can compare with the natural gum, the nearest approach to a proper color being the celluloid base. When a material shall have been discovered possessing the valuable properties of the vulcanite combined with the beauty of a porcelain artificial gum, dental prosthesis will have nearly reached perfection.

The late Dr. James W. White, in a popular treatise on "The Teeth," remarked: "The observant dentist will take into account complexion, age, sex, height, the color of hair and eyes, and other characteristics of the individual, when selecting teeth to replace lost ones; and the manufacturer should be skilled in the observance of the varied classes of denture required. To inattention in this direction on the part of the dentist, or to dictation on the part of the patient, is to be charged the unseemly incongruities constantly staring the observer in the face from mouths whose lost organs have been replaced in disregard of this universal law. No matter how anatomically correct or how skillfully adapted for speech and mastication an artificial denture may be, yet if it bear not the relation demanded by age, temperament, facial contour, etc., it cannot be otherwise than that its artificiality will be apparent to every beholder. Artificial teeth should be natural as to shape, color, and vital appearance; there should be a nice blending of the colors of the body and enamel, not an abrupt union of the two; there should be the precise amount of translucency and the peculiar texture of the surface; and these characteristics should be maintained by artificial light as well as by daylight; for many teeth

which in daylight look reasonably well have an artificial appearance when exposed in the mouth to an artificial light. They should also possess strength sufficient for the uses for which they are designed. Besides all this there must be taken into account the varying forms of the jaws or maxillary ridge, so that the dentist may be enabled to select teeth which are adapted to each particular case, and which can be made to articulate nicely with other or with the natural teeth, if there are any remaining in the mouth; otherwise his best efforts will not secure a good appearance, comfort to the wearer, or usefulness in mastication."

CHAPTER III.

RETENTION OF ARTIFICIAL TEETH.

The methods of retaining artificial teeth in place are—first, by pivoting to the natural roots; second, by attaching to metallic or other kind of base-plate, secured either by, 1, clasps or caps; 2, spiral springs; or, 3, atmospheric pressure. The peculiar advantages of each of these methods we shall now proceed to point out, and the cases to which they are particularly applicable.

ARTIFICIAL TEETH PLACED ON NATURAL ROOTS.

This method of securing artificial teeth was formerly, on account of its simplicity, more extensively practiced than any other; and, under favorable circumstances, it answers as well as any that can be adopted. If the roots on which they are placed be sound and healthy, and the back part of the jaws supplied with natural teeth, so as to prevent those with which the artificial antagonize from striking them too directly, they will subserve the purposes of the natural organs as perfectly as any other description of dental substitute, and can be made to present an appearance so natural as to escape detection upon the closest scrutiny. If properly fitted and secured, not only is their connection with the natural roots not easily detected, but they may render valuable service for many years.

The pivoting of the lower incisors, from their small size and the dangerous sequelæ of abscess, is frequently an unsatisfactory operation. Many upper laterals are also too small to admit a pivot. In practice the pivoting of cuspids is seldom called for. These teeth being very persistent, their loss usually implies that of many, perhaps all others, and the entire deficiency is replaced by teeth attached to a base-plate.

The insertion of an artificial tooth on a diseased root, or on a root having a diseased socket, is almost always followed by injurious consequences. Filling the root, together with proper accompanying treatment, will sometimes so completely arrest disease as to make pivoting safe; but there is always risk in these cases. The morbid action already existing in the root or its socket is aggravated by the operation, and often caused to extend to the contiguous parts, and occasionally even to the whole mouth. Even in a healthy root it is not always proper to apply a tooth immediately after having prepared the root. If any irritation is produced by this preparatory process, the tooth should not be inserted until it has wholly subsided. The neglect of this precaution not unfrequently gives rise to inflammation of the peridental membrane and to alveolar abscess.

Apart from the condition of the root, the question of pivoting—or of a plate tooth without gum resembling a pivot tooth—may depend upon the adjoining tooth or roots. If in any space to be supplied one root is absent all should be extracted, for the peculiar beauty of a pivot tooth is lost if its neighbor has an artificial gum.

Although this method of securing artificial teeth has received the sanction of the most eminent dental practitioners, and is one of the best that can be adopted for replacing loss in the six upper front teeth, yet, on account of the facility with which the operation is performed, it is often resorted to under most unfavorable circumstances, in consequence of which the method has been undeservedly brought into discredit. Apart from the proneness of operators to resort to this method when its adoption is unjustifiable, we may name two objections to the use of pivot teeth as formerly prepared and inserted. First, the difficulty of preventing the presence of secretions between the crown and root, which make the breath offensive and cause the root gradually to decay. Secondly, the more or less rapid enlargement of the canal, requiring frequent replacement and the ultimate loss of the root. The more recent methods, however, many of which consist in improvements upon the older methods, have obviated these objections in a great measure.

The efforts of the economy for the expulsion of the roots of the bicuspid and molar teeth after the destruction of their lining membrane, are rarely exhibited in the case of roots of teeth occupying the anterior part of the mouth. This circumstance has led us to believe that the roots of these teeth receive a greater amount of vitality from their investing membrane than do the roots of those situated further back in the mouth; and that the amount of living principle thus supplied is sufficient to prevent them from becoming manifestly obnoxious to their sockets.

Another explanation assumes the equal vitality of all the roots, and attributes the persistence of front roots, upon which a crown has been placed, to the continuance of that pressure to which it was subject so long as it had its natural crown. It is asserted in maintenance of this view, that front roots left to themselves will disappear in the same manner as bicuspid and molar roots, and that the latter may be retained if the artificial crown (attached to a plate) is set upon them; also, that the process of expulsion is analogous to that by which a tooth is elongated which has lost its antagonist.

It is well known that a dead root is always productive of injury to the surrounding parts, and that nature calls into action certain agencies for its expulsion. Therefore, attaching a tooth to a completely dead root is manifestly improper; but the roots of the front teeth are rarely entirely deprived of vitality, and hence, after the destruction of their pulps, they remain useful for many years without very obviously affecting the adjacent parts.

Teeth, attached to a plate, and resting upon natural roots which are in as healthy condition as it is possible for such roots to be, have all the beauty which so strongly recommends pivot teeth. They are not so securely held in position; but the ability to remove them is in itself an advantage. This method is applicable in many cases where the drilling for a pivot is impossible. The reader is referred to the chapter describing the different methods of pivoting teeth.

THE ARTIFICIAL TEETH SECURED BY CLASPS.

This method of securing artificial teeth, first introduced by the late Dr. James Gardette, of Philadelphia, is, perhaps, in particular and otherwise favorable cases, one of the firmest and most secure that can be adopted. By this means, the loss of a single tooth, or of several teeth, may be supplied. A plate may be so fitted to a space in the dental circle and secured with clasps to other teeth as to afford a firm support to six, eight, or ten artificial teeth.

Teeth applied in this way, when properly constructed, will last for several years, and sometimes during the life of the individual. But it is essential to their durability that they should be correctly arranged, accurately fitted, and firmly secured to the plate; that the plate itself be properly adapted to the gums, and the clasps attached with the utmost accuracy to teeth firmly fixed in their sockets.

Gold is perhaps the best material that can be employed for both plate and clasps. Since the application of vulcanized rubber to dental purposes, plates of this latter material with gold clasps attached have been much used. When gold is employed for the plate it should be from 20 to 21 carats fine, and from 18 to 19 for the clasps.

If gold of an inferior quality is used, it will be liable to be acted on by the secretions of the mouth. Platina perfectly resists the action of these secretions, and would, perhaps, answer the purpose as well as gold were it not for its softness and pliancy; in full cases, and in some partial cases, the shape of the plate may more or less overcome this difficulty, especially when, as in the continuous gum work, stiffened by other materials.

The plate should be thick enough to afford the necessary support to the teeth; but not so thick as to be clumsy or inconvenient from its weight. The clasps generally require to be about one-third or one-half thicker than the plate, and sometimes double the thickness. The gold used for this purpose is sometimes prepared in the form of half-round wire; but in the majority of cases it is preferable to have it flat, as such clasps afford a firmer and more secure support to artificial teeth than those that are half round; they also occasion less inconvenience to the patient, and are productive of less injury to the teeth to which they are attached.

Artificial teeth, applied in this way, may be worn with great comfort and can be taken out and replaced at the pleasure of the person wearing them. It is important that they should be very frequently cleansed to remove the secretions of the mouth that get between the plate and gums and between the clasps and teeth, which, becoming vitiated, may irritate the soft parts and corrode the teeth and taint the breath. This precaution should on no account be neglected. Great care, therefore, should be taken to fit the clasps in such a manner as will admit of the easy removal and replacement of the piece, and also that they may not exert any undue pressure upon the teeth to which they are applied.

If the clasp, in consequence of inaccurate adjustment, strains the position of the tooth in its socket, it may excite inflammation in the peridental membrane, and the gradual destruction of the socket will follow as a natural consequence. Also, if the clasp press too closely upon the neck of the tooth it may develop a morbid sensibility in the cementum, causing great annoyance and possibly exciting inflammation and alveolar absorption or loosening of the tooth.

Some years since Dr. Goodall obtained a patent for a method of retaining partial sets of artificial teeth by elastic or spring plates of vulcanized rubber, the utility of which, indiscriminately applied, as well as the validity of the patent, some were disposed to doubt, contending that these plates differ but little from metallic ones formerly in use, constructed in the same manner, and described as partial or stay-clasps.

This form of clasp, instead of embracing the natural tooth, simply presses against the inner surface of the contracted portion of the crown

near the gum, with a force which is sufficient to keep the substitute in place.

Professor Austen's method of taking plaster impressions in partial cases was designed by him in 1858, with special reference to obtaining an accurate copy of the inner surface of bicuspids and first molars. Accurate fitting of the vulcanite plate against one or two such teeth on each side prevents lateral motion and gives great stability to the piece. It takes the place of the vacuum cavity with much better results; in fact, he regarded this form of stay-plate essential to every partial piece not clasped, whilst he regarded the cavity worse than useless.

The reader is referred to the chapter describing the method of retention by clasps.

ARTIFICIAL TEETH WITH SPIRAL SPRINGS.

The difference between the method of applying artificial teeth last noticed and the one now to be considered consists in the manner of confining them in the mouth. The former is applicable in cases where there are other teeth in the mouth to which clasps may be applied; the latter is designed for confining a double set; more rarely a single set or part of a set. When plates with spiral springs are used, the teeth are attached to them in the same manner as when the clasps are employed, but instead of being fastened in the mouth to other teeth, they are kept in place by means of the spiral springs, lying one on each side of the artificial dentures between them and the cheeks, passing from the upper piece to the lower.

Spiral springs were formerly much used, and various other kinds of springs have since been suggested. When spiral springs are of the right size and attached in a proper manner they afford a very sure and convenient support. They exert a constant pressure upon the artificial pieces, whether the mouth is opened or closed. They do not interfere with the motions of the jaw, and, although they may at first seem awkward, a person will soon become so accustomed to them as to be almost unconscious of their presence. They are, however, liable to derangement from accident; they make the piece awkward to handle in the necessary daily cleansing; they retain the secretions offensively, and not unfrequently are a source of much irritation to the cheek.

It is, therefore, a subject of congratulation that successive improvements in the process of adapting the plate to the mouth have gradually lessened the number of cases in which spiral springs are thought necessary. It is now rare to meet with a case in which they are absolutely essential for the permanent retention of the piece. Occasional use is made of them for the temporary retention of a piece made soon after extraction, in which the plate is designedly made

more even than the irregular alveolar border, which plate cannot, of course, fit the mouth until the inequalities of the gum have yielded to the pressure of the plate.

TEETH RETAINED BY ATMOSPHERIC PRESSURE.

The method of confining artificial teeth in the mouth last described is often inapplicable, inefficient, and troublesome, especially for the upper jaw; in such cases the atmospheric pressure, or suction method, is very valuable. It was, for a long time, thought to be applicable only to an entire upper set, because it was supposed that a plate sufficiently large to afford the necessary amount of surface for the atmosphere to act upon could not be furnished by a piece containing a smaller number of teeth. Experience, however, has proved this opinion to be incorrect. A single tooth may be mounted upon a plate presenting a surface large enough for the atmosphere to act upon for its retention in the mouth; but when only a partial upper set is required it is often more advisable to secure the piece by means of cap-crowns to which a bridge is attached. For a like reason it was thought that the narrowness of the inferior alveolar ridge would preclude the application of a plate to it upon this principle, and in this opinion the author once coincided; but he has succeeded so perfectly in confining lower pieces by this means that he now never finds it necessary to employ spiral springs for their retention.

The principle upon which this plan is founded may be simply illustrated by taking two small blocks of marble or glass, the flat surfaces of which accurately fit each other. If, now, the air between them is replaced by water, the atmospheric pressure upon their external surfaces will enable a person to raise the under block by lifting the upper. Upon the same principle a gold plate, or any other substance impervious to the atmosphere and perfectly adapted to the gums, may be made to adhere to them.

The firmness of the adhesion of the plate or base to the gums depends on the accuracy of its adaptation. If this is perfect it will adhere with great tenacity, but if the plate is badly fitted or becomes warped in soldering on the teeth, its retention will often be attended with difficulty. It is also important that the teeth should be so arranged and antagonized that they shall strike those in the other jaw on both sides at the same instant. This is a matter that should never be overlooked, for if they meet on one side before they come together on the other, the part of the plate or base not pressed upon may be detached, and, by admitting the air between it and the gums, cause it to drop.

Since in the act of mastication pressure is made on one side with no

counter-pressure on the other, this inequality will not necessarily detach a well-made piece. But when the upper molars are set so far from the median line of the mouth that the line of pressure falls outside the alveolar ridge, it is difficult to retain the best-fitting piece in place during mastication.

It is also of the utmost importance that, by proper selection of the impression material and judicious management of subsequent processes, the plate should bear upon the ridge more than upon the palate. In doing this, however, no more space should be left than a few days' wear will obliterate, giving absolute contact over the entire surface. For there is no kind of space, cavity, or chamber which gives so complete a vacuum as contact, or which secures such permanently useful adhesion of the plate.

The application of artificial teeth on this principle has been practiced for a long time. Its practicability was first discovered by the late Mr. James Gardette, of Philadelphia. But the plates formerly used were ivory instead of gold, and could seldom be fitted with sufficient accuracy to the mouth to exclude the air; so that, in fact, it could hardly be said that they were retained by its pressure; except in that class of cases in which the mouth, by virtue of a soft membrane, has power to adapt itself to the plate. Unless fitted in the most perfect manner, the piece is constantly liable to drop; and the amount of substance necessary to leave in an ivory substitute renders it so awkward and clumsy that a set of teeth mounted upon a base of this material can seldom be worn with much comfort or satisfaction.

The firmness with which teeth applied upon this principle can be made to adhere to the gums and the facility with which they can be removed and replaced renders them, in many respects, more desirable than those fixed in the mouth with clasps. But unless judgment and proper skill are exercised in the construction of the work, a total failure may be expected, or, at least, the piece will never be worn with satisfaction and advantage.

There were few writers, at the time of the publication of the first edition of this work, who had even adverted to this mode of applying artificial teeth. Drs. L. S. Parmly and Koecker had each bestowed on it a passing notice. The former, in alluding to the subject, thus remarks: "Where the teeth are mostly gone in both or in either of the jaws, the method is to form an artificial set by first taking a mold of the risings and depressions of every point along the surface of the jaws, and then making a corresponding artificial socket for the whole. If this be accurately fitted it will, in most cases, retain itself sufficiently firm by its adhesion to the gums for every purpose of speech and mastication."

Modifications of the atmospheric pressure principle have been made since 1845, by constructing the plate with an air-chamber or cavity, so that when the air is exhausted from between it and the parts against which it is placed, a more or less complete vacuum is formed, causing it to adhere when first introduced with greater tenacity to the gums than a base fitted without such cavity. This modification might be termed an improvement were it not that its introduction has become so unnecessarily general, has so often induced a diseased condition of the mucous membrane, and has led to a slovenly, careless method of swaging and fitting plates. For these and some other reasons, Professor Austen regarded its introduction as a positive detriment, at the same time that he acknowledged its occasional utility. He argued that theory and practice alike condemn the use of a cavity for the permanent retention of any piece, and suggests for its temporary retention, whilst the work is going through its stage of adaptation, some other plan than this permanent disfigurement. The so-called vacuum cavity can, at best, be only partially a vacuum, hence cannot give the amount of atmospheric pressure that perfect contact will. So long as it acts in the retention of a piece it necessarily draws the yielding membrane into the space, and must ultimately fill it. When this is done, the piece is evidently retained by the "vacuum of contact." If, in any case, the mouth does not show the size and depth of the cavity imprinted on the palate, it proves that the vacuum force is not exerted, and that the piece is retained by contact of the parts around the cavity. In these cases, of constant occurrence, the cavity diminishes the adhesion of the plate, and can only be of service where it helps to remove pressure from a hard palate. But as this can be done in a better way, it is no argument in favor of the cavity.

The only cases in which this chamber is permanently useful are very flat mouths with scarcely any perceptible ridge. A sharply defined cavity, varying in depth from one-half to one line, according to the softness of the membrane, when filled by this membrane, tends to prevent any lateral motion of the piece, so troublesome in such cases.

Partial pieces not retained by clasps, or the lateral pressure of stays, or their closeness of adaptation, are never permanently improved by the cavity. Even in pieces made soon after extraction the temporary action of the cavity is of questionable utility (see Chapter XIII). Devices known as "surface-cohesion forms" have also been suggested, which consist of thin metallic plates, the surfaces of which are covered with minute papilliform prominences, which, by displacement of mucus at the points of gum contact, effect surface cohesion and cause no irritation. They can be adapted to both upper and lower dentures.

CHAPTER IV.

PREPARATORY TREATMENT OF THE MOUTH.

The condition of the mouth is not sufficiently regarded in the application of artificial teeth, and to the neglect of this the evil effects that so often result from their use are frequently attributable. An artificial appliance, no matter how correct it may be in its construction and in the mode of its application, cannot be worn with impunity in a diseased mouth. Of this fact every day's experience furnishes the most abundant proof. Yet there are men in the profession so utterly regardless of their own reputation and of the consequences to their patients as wholly to disregard the condition of the mouth, and are in the constant habit of applying artificial teeth upon diseased roots and gums, or before the curative process after the extraction of the natural teeth is half completed.

The dentist, it is true, may not always be to blame for omitting to employ the means necessary for the restoration of the mouth to health. The fault is often with the patient. There are many who, after being fully informed of the evil effects which must of necessity result from such injudicious practice, still insist on its adoption. But the dentist, in such cases, does wrong to yield his better informed judgment to the caprice or timidity of his patient, knowing, as he should, the lasting pernicious consequences that must result from doing so. If he is not permitted to carry out such plan of treatment as may be necessary to put the mouth of his patient in a healthy condition previously to the application of artificial teeth, he should refuse to render his services. No professional man can be permitted to plead in excuse for any professional error that his patient over-persuaded him. No community will accept such excuse, or hold the patient in any degree responsible for the consequences.

Dr. Koecker, in treating upon this subject, says: "There is, perhaps, not one case in a hundred requiring artificial teeth in which the other teeth are not more or less diseased, and the gums and alveoli, also, either primarily or secondarily affected. The mechanical and chemical bearing of the artificial teeth, even if well contrived and inserted upon such diseased structures, naturally becomes an additional aggravating cause of disease in parts already in a sufficient state of excitement; if, however, they are not well constructed, and are inserted with undue means or force, or held by too great or undue pressure, or by ligatures or other pernicious means for their attachment, the morbid effects are still more aggravated, and a general state of

inflammation in the gums and sockets, and particularly in the periosteum, very rapidly follows. The patient, moreover, finds it impossible to preserve the cleanliness of his mouth; and his natural teeth, as well as the artificial apparatus, in combination with the diseases of the structures, become a source of pain and trouble; and the whole mouth is rendered highly offensive and disgusting to the patient himself as well as to others."*

The first thing, then, claiming the attention of the dentist, when applied to for artificial teeth, is to ascertain the condition of the gums and of such teeth as may be remaining in the mouth. If either or both are diseased, he should at once institute such treatment as the circumstances of the case may indicate; but as this has been described in a preceding chapter, the reader is referred for directions upon the subject to what is there said. Without, however, repeating previous medical and surgical directions, a few brief hints are necessary as to what teeth or roots should be extracted and what allowed to remain in preparation for a dental plate.

All incurably diseased roots or teeth should be removed, also all roots of molars in either jaw, and all roots, without exception, in the lower jaw. Firm and healthy roots of bicuspids may sometimes be retained, the plate coming to the inner edge of such root and the artificial crown resting upon it. It is desirable to retain upper incisors or canine roots, unless an adjacent tooth has lost its root or is incurably diseased. These cases of retention of roots presuppose the presence of other teeth; for when only roots remain in the jaw they must be extracted. Also, they must be removed, however sound, if they are sources of irritation in, or are partially covered with, mucous membrane.

Very loose teeth, although not carious, should be extracted; but teeth in which caries or abscess can be permanently cured rank as sound teeth. All sound teeth must be retained, if there are more than four in either jaw, unless some peculiar circumstances justify their removal. Cases of this kind are so varying that no fixed rule can be laid down; but a few cases may be given in illustration of the principles that should guide the practitioner.

Two, three, or four molars alone remaining should be retained, especially if they have antagonists. They do not complicate the construction of the piece or interfere with its utility; but they should not be clasped, since the whole weight being in front of the clasp brings too much strain on the teeth. Two, three, or four incisors alone remaining cannot be extracted except by request of the patient; for

* Koecker's "Essay on Artificial Teeth," pp. 27, 28.

although they complicate the construction, and may interfere somewhat with the strength and beauty of the work, they may be too valuable to justify their loss. The cuspids must be retained, if sound, not displaced, and free from alveolar absorption, although their retention may greatly complicate the work.

In cases of protrusion of the lower jaw, it may be advisable to extract the five front teeth in either jaw, where these are the sole remaining ones, with a view to correct, in part, the protrusion of the mouth. But this cannot be done without fullest consent of the patient; even then is scarcely advisable unless these teeth are frail in texture, or their position amounts to deformity.

In all cases it should be the rule never to sacrifice a sound tooth for the purpose of replacing an artificial one, unless the benefit of the exchange is so undoubted as to be recognized by both patient and operator.

When artificial teeth are to be secured in the mouth in any other way than by pivoting upon the roots, if the patient desires but one piece, sufficient time should elapse before its insertion for the completion of those changes in the alveolar ridge that follow extraction.

It is often necessary to wait from eight to fifteen months, after the removal of the natural teeth, for the completion of these changes. Comparatively few persons, however, are willing to remain for so long a time without teeth; nor, on many accounts, is it desirable that they should. In this long interval the lips lose somewhat their natural expression, and the under jaw forgets its natural motion and inclines to project. The artificial piece or pieces feel more awkward and unmanageable than if inserted at once; they also interfere more with the articulation and motions of the tongue, which have become accustomed to the absence of the teeth.

Hence the insertion of artificial pieces may become advisable very soon after extraction — the interval varying from hours or days to weeks or months. In some of these cases the piece will have to be remodeled at short intervals; in other cases the piece, as first made, continues to be worn for many years with much comfort. It is not easy to explain these differences. Much depends upon the nature of the mucous and submucous tissues, whether hard or soft; and much also upon the manner in which the alveolar ridge changes. It may take place rapidly, and with slight regard to the shape of the plate; in which case the patient has to use much tact in retaining the piece in place. Or it may take place slowly, following, as it is apt more or less to do, the shape of the plate; in which case it may be worn with some comfort, or even with great satisfaction, for a long time.

A plate made immediately after extraction should not fit the ridge exactly; but allowance should be made for the rapid absorption of the prominent edges of the alveoli. Some practitioners advise the anticipation of this process by "paring down" the alveolar ridge. This "bold surgery" has its advantages and its advocates. The operators say it does not hurt much; but the testimony of the patient on this point is more trustworthy.

The almost universal use of the term "temporary," applied to a piece made within six months after extraction of the teeth, is much to be regretted. It tempts the dentist to a slovenly style of half-made work, good enough, in his estimation, for what is so soon to be replaced. It also renders the patient reluctant to make proper compensation for the time and skill employed. Both feelings react, until it has become a notorious fact that much low-priced work passes from the hands of skillful mechanicians which they would indignantly disown as specimens of their workmanship.

Yet they are specimens which a community is right in judging by. It is unfortunate for dentistry that so many, using their best efforts, accomplish poor results. But it is infinitely more damaging to its character that a skilled operator should, under any pretext, permit himself to be false to the trust reposed in his professional capacity. A chain is judged by its weakest link, and a workman's reputation turns on his poorest work. This seemingly harsh verdict is a just one, because necessary to keep the majority of men to the full measure of their ability.

Let the work be done as if it never was to be done again. Many circumstances may prevent the return of the patient; it also frequently happens that no necessity is felt, especially if properly done, for the renewal of the piece. If the patient understands that the necessity of renewal is not in the work itself, but arises from unavoidable changes in the mouth, there will be no difficulty about proper compensation. But if the absurd practice of half-price at one time for what receives full price at another must be maintained, then by all means let the second piece be the half-paid one.

The point, however, involves far higher questions than the one of fees. No dentist who properly respects himself or his profession will, either on the score of insufficient pay or temporary use, permit himself to issue two grades of work. Like Pharaoh's lean kine, the low grade will, slowly, perhaps, but inevitably, destroy the high grade. The only safe rule is "excelsior" in every case.

CHAPTER V.

CROWN AND BRIDGE-WORK.

Previous to the preparation of a natural root for the reception of an artificial crown, the remaining teeth and gums, if diseased, should be restored to health. This done, such portion of the crown as may not have been previously destroyed by caries should be removed.

A simple method of performing this part of the operation, when much of the crown remains, consists in cutting the tooth about three-fourths off with a file, a very fine saw (Fig. 613), or corundum or

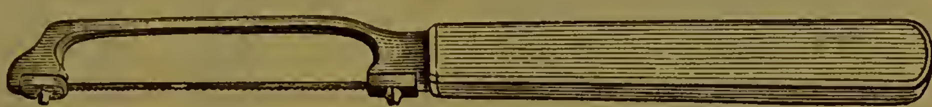


Fig. 613.

carborundum disc, and then removing it with a pair of excising forceps. But the forceps should not be applied until the tooth has been cut on every side, nearly to the pulp cavity, and even then great care is necessary to prevent jarring, or otherwise injuring the root. When too large a portion of the crown is clipped off suddenly with excising forceps, the concussion is often so great as to excite peridental inflammation and sometimes to fracture the root.

When excising forceps are used in this way, they should be strong, so as not to spring under the pressure of the hand, with cutting

Fig. 614.

edges about an eighth of an inch wide (Fig. 614). But we should prefer, where a large part of the crown is left, to remove it entirely with the fine saw, or separating file, or corundum disc. Where there is only a jagged remnant of the crown left, it should be gradually cut away by a pair of cutting forceps made as light as possible, with a spring between the blades of the handles to keep them apart. The cutting edges may be shaped as in the ordinary excising forceps (Fig. 614), or somewhat like the beaks of Parmly's duck-bill root forceps, represented in Fig. 615.

After the removal of the remaining portion of the crown, the

pulp, if still alive, should be immediately destroyed by introducing a silver or untempered steel wire, or barbed broach, up to the extremity of the root by giving it at the same time a quick rotary motion. It is important that the instrument used for this purpose should be soft and yielding, otherwise any sudden motion of the patient might break it off in the tooth. Its extremity should also be

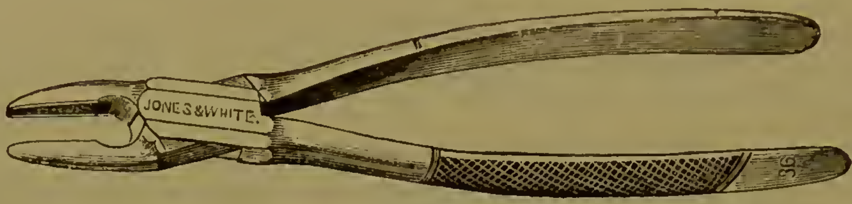


FIG. 615.

barbed or bent so as to entangle and drag out the pulp when withdrawn. (See Fig. 509, page 556.)

The pulp having been destroyed, the remainder of the operation will be painless. The root may now be filed or ground off a little above the free edge of the gum with an oval or half-round file, or a corundum wheel with a round edge. The file should be new and sharp, so as to cut rapidly, but not too coarse, lest it jar the root too much.

FIG. 616.

FIG. 617.

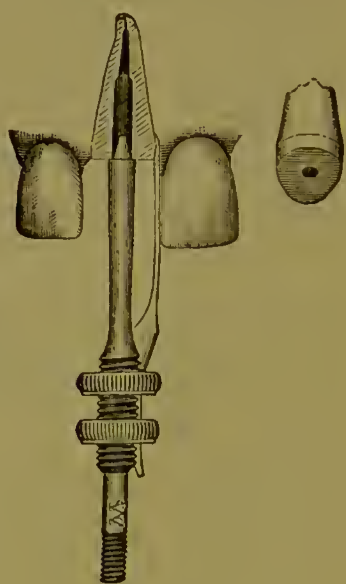
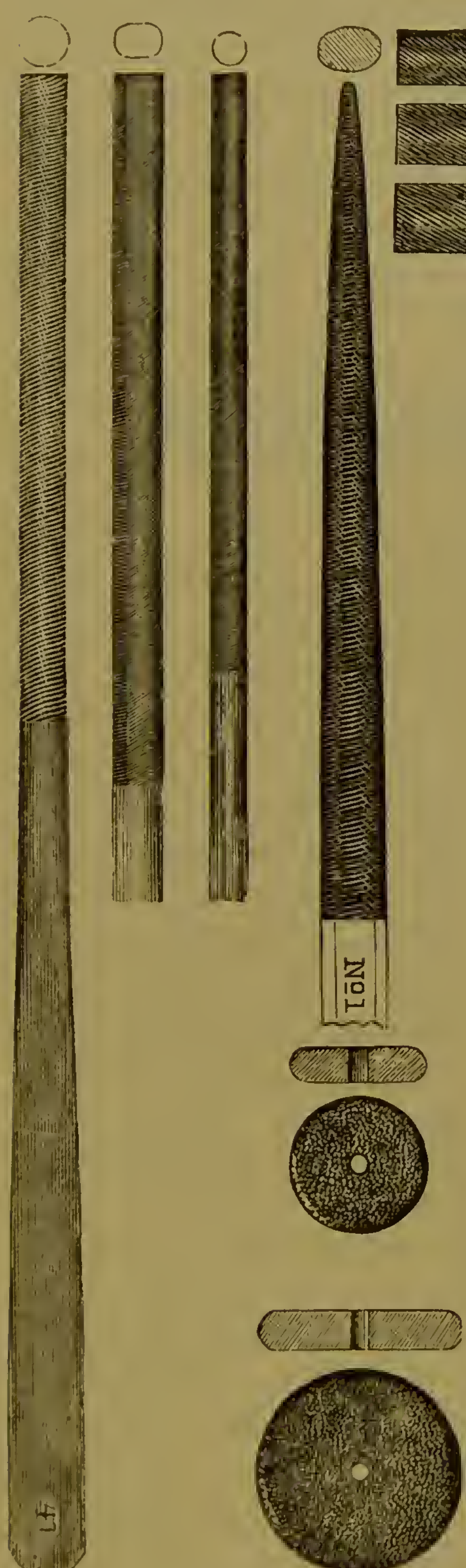


FIG. 618.

It must be kept cold and clean by frequently dipping in water; also the corundum wheel. Fig. 619 represents pivot files and wheels. The exposed extremity of the root after having been thus filed should present a slightly arched appearance, corresponding with the festooned shape of the anterior margin of the gum. Fig. 620 represents the Herbst rotary file for rapidly cutting natural roots to receive artificial

crowns. Fig. 621 represents safe-side corundum crown-wheels to grind off the root without injuring the adjacent tooth. Instruments called root-trimmers or reducers are then employed for trimming the edges,



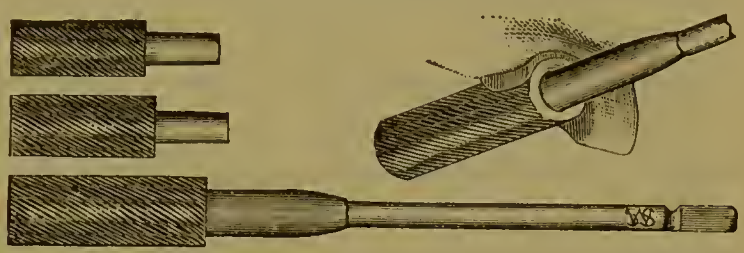


Fig. 620.

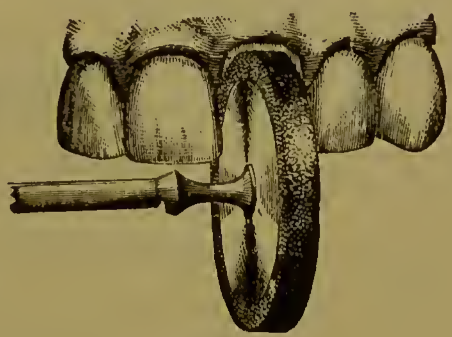


Fig. 621.

or in the case of collar-crowns, for reducing the diameters of roots over which collars are to be placed.

Figs. 616, 617, and 618 represent Evans', Starr's, and How's root-trimmers or reducers.

After having completed this part of the operation, the natural canal in the root should be slightly enlarged with a bur-drill, or a broach prepared for the purpose. A slightly projecting point on the end of the drill will serve, by entering the canal, to guide the instrument, which must be held steadily in one direction. The canal thus formed in the root for the pivot should never exceed the sixteenth part of an inch or a line in diameter, or a quarter or three-eighths of an inch in length.

Fig. 619.

If, from any peculiar constitutional susceptibility, there is reason to apprehend inflammation of the peridental membrane, the insertion of the tooth may be delayed a few days for the subsidence of any irritation which may have been

occasioned by the preparation of the root. It will be prudent to do this in all cases, although it rarely happens that the operation is followed by any unpleasant effects unless the pulp has previously lost its vitality by spontaneous disorganization or been destroyed by an arsenical application.

In such cases the contents of the canals must be removed, and the canals must be disinfected with peroxid of hydrogen, and a permanent aseptic condition, by mummification of the contents of the tubuli, be established, together with closure of the apical foramen, after the root-canal is prepared.

The root-canal is then opened by means of the drills and reamers represented by Figs. 515 and 516, page 559, and when this is accomplished it is syringed out with tepid water, and, after drying with cotton, is dehydrated with absolute alcohol, or by a current of hot air introduced by a hot-air syringe. The application of an antiseptic solution, such as bichlorid of mercury or peroxid of sodium, may follow the dehydrating process in all cases where such agents are deemed necessary for the purpose of establishing a purely aseptic condition.

After having prepared the root, an artificial crown of the right shape, color, and size is accurately fitted to it. It should touch every part of the filed extremity of the root, and be made to rest firmly upon it, to give security of support, and to exclude food and other substances which, by their decay, will give rise to unpleasant odors. Care must also be used to have the tooth placed in exact line with the other teeth, not inclining unnaturally to either side, and not so long as to touch the lower teeth when the mouth is closed. To fit the crown accurately is often a tedious process and wearies the patient. To avoid this an impression of the exposed end of the root and of the space between the adjoining teeth may be taken and the crown adapted to the model, which should be hardened by varnish or soluble glass; an antagonizing model is also useful.

The canal in the root and that in the artificial crown should be directly opposite to each other.

In selecting a suitable artificial crown, it is often difficult to find the several conditions of length, width, color, and position of pivot hole just as required. The last two cannot be changed, but the first two may often be modified by the corundum wheel. If the color cannot be exactly matched, it is perhaps better to select one a shade darker, rather than lighter.

For grinding the edges, sides, or base of the tooth, any of the hand or office foot-lathes in use will answer, or the corundum or carborundum points may be employed.

The artificial crown is secured to the root by means of a pivot or

post made of metal; gold, platinum, or platinum and iridium is to be preferred, inasmuch as silver or any baser metal is liable to be oxidized by the fluids of the mouth.

Wood, either seasoned hickory or locust, was formerly employed for the post, but metal is now generally employed, as it presents many advantages over the wood on account of strength, cleanliness, and durability.

It is important that the pivot should exactly equal the depth of the canal. If too long, the crown will not go up to its place; if too short, there will be either an unnecessary weakening of the root or the crown will be insecure. A small piece of smooth wire or knitting needle,

FIG. 622.

with a sliding collar of wood or gutta-percha, forms a simple instrument for measuring the depth of the canal in the root. Fig. 622 represents a convenient gauge for this purpose.

The end of the metallic post going into the artificial crown may be fastened in either of the following ways: First, by cutting a screw on it with a screw-plate, and then filling the post-hole with zinc cement and inserting the end of the post into it, which should be large enough to nearly fill the cavity. The projecting part of the pivot should be about half an inch in length. It is generally made square and pointed, as in the figure. The appearance of a porcelain tooth prepared with a metallic pivot for insertion in this manner is shown in Fig. 623.

FIG. 623.

FIG. 624.

In some cases a plate tooth may be considered preferable to one made expressly for pivoting. The manner of attaching a post to the former is as follows: The root is first prepared, after which an impression is taken; from this a plaster model is made, and from the latter metallic dies. This done, a piece of gold plate, large enough to cover the root, should be swaged up between the dies; a plate tooth of the proper size, shape, and color is then fitted to the root, backed with gold, and soldered to the plate. To the upper convex surface of this last, and immediately beneath the canal in the root, a metal pivot is attached. The position and direction of this pivot is thus secured. Press the plate, covered with a very thin film of wax, against the root; at the point opposite the canal, thus marked on the plate, drill a hole; through this pass a gold pivot into the canal; press softened sealing wax around the part of the pivot (made pur-

posely too long) below the plate, and remove the fixture from the mouth. Invest the upper part of the pin and plate in plaster (keeping it, by means of a minute collar of wax, out of the hole through which the pin passes), remove the sealing wax, cut off the pin even with the plate, and solder. A front and side view of a tooth thus prepared is shown in Fig. 624.

Porcelain crowns are now made with metallic posts baked in position. Fig. 625 represents such crowns with platino-iridium posts.

The double pin in the molar crowns prevents the loosening of these teeth by the rotary movements of mastication, which by means of the cusps exert such leverage as to turn and break down the ordinary crown where only one pin is used.

The roots are ground concave to fit the crowns with corundum or carborundum points or a countersink bur, and the close joints are made well under the gum, setting the pins with oxyphosphate cement.

It sometimes happens that the natural root, instead of occupying its proper position in the jaw, runs very obliquely; so that if the pivot connecting the artificial tooth to it be straight, the latter will

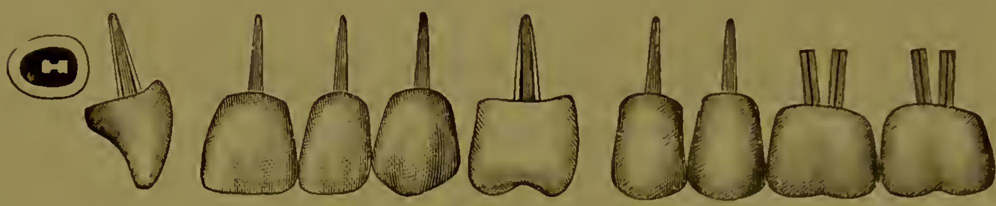


FIG. 625.

either overlap the adjoining teeth or else project outward or inward. To obviate this an angle should be given to the pivot immediately at the point of junction between the tooth and root. If this obliquity be slight, the pivot can easily be bent to suit; but in cases of greater obliquity a pivot or post made for the case will be required.

Some cases are met with presenting a more formidable difficulty; as, for example, when the root is situated behind the circle of the other teeth. In a case of this sort a different kind of tooth and an entirely different course of procedure are necessary. After having prepared the root, an impression of the parts is taken in wax, from which a plaster model is obtained, and from this two metallic dies. With these a gold plate is to be swaged, extending backward so as to cover the root, and forward to form a line with the outer circle of the teeth. To the posterior part of the plate covering the root, and directly beneath the cavity in it, a gold pivot about three-eighths of an inch long, is soldered, and to the anterior part of it a plate tooth of the right size, shape, and shade is attached. A hollow gold

screw is now introduced into the root, and into this the gold pivot is inserted; or the post may be attached to the root with zinc cement. A right superior central incisor mounted on a plate with a pivot, for insertion in the manner here described, is represented in Figs. 626 and 627.

Fig. 626.

Fig. 627.

A method of inserting an artificial tooth on a metallic pivot is described by the late Dr. James B. Bean in Vol. III, 1869–70, of the *American Journal of Dental Science*: "Having filed or sawed off the remaining portions of the crown, the exposed surface of the root is smoothly filed to within one-half or one-fourth of a line below the margin of the gum, giving it a slight concave appearance, so as to accommodate the neck of the *plate tooth* which is to rest against it. It is well at this stage of the operation to stop the canal loosely with a pellet of cotton or floss silk saturated with spirits of camphor, and to dismiss the patient for two or three days. If no inflammation be present, the canal may then be cleaned out and carefully filled with gold foil from the apex to within four or five lines of the orifice.

"The remaining portion of the canal not filled should now be enlarged to about one line in diameter, if the size of the root will admit of it, down to the gold filling, making the bottom smooth and solid and the sides parallel. The orifice, to the depth of nearly a line, is again enlarged with a bur-drill to about two lines in diameter, and a small groove or undercut is formed around the margin for the retention of the gold filling subsequently to be introduced around the tube.

"Hollow gold, jeweler's wire, or simple gold tubes made of gold plate may be employed. If the latter is chosen, it is formed by bending a piece of ordinary gold plate around a wire, so as to form a cylinder sufficiently large to fit the smaller portion of the canal prepared for it; then solder with the finest gold solder. A piece of the tube half an inch in length should be cemented with shellac into a hole bored through a piece of wood half an inch in thickness, to serve for a handle; the interior is then carefully dressed out with a jeweler's broach which has a slight taper, making it smooth and regular within. A solid gold wire pivot is now carefully filed and fitted by grinding it with fine emery and water, making a 'ground joint,' whereby the pivot is firmly held when in place. Any portion of the wire that may project beyond the smaller end of the tube should be cut evenly off, while at the larger end it should project at least one-fourth of an inch.

"The tube must be taken out of the cement and a piece of plate

soldered to the smaller end, forming a *bottom*. An easier flowing solder should be used for this, so as not to disturb the first. This tube thus formed, after being cleansed in acid and smoothly filed, is ready to be inserted into the root.

"Some have proposed to cut a screw on the tube, whereby it is firmly secured in its place, and to fill then around with gold. But the most convenient way is to cut a number of barbs with a sharp knife, on the outside, looking toward the open end; this retains the gold in place nearly or quite as well as the screw. Being made so as to enter the root rather loosely, several folds of gold foil are wrapped around it, and after carefully drying the parts with bibulous paper—the pivot being in its place in the tube—the whole is forced to the bottom of the cavity and the loose portions of foil removed; zinc cement may also be used to secure the tube.

"Another method is to fill the space around the tube with gold. The gold pivot is now removed and the tube carefully sawed or filed off nearly level with the end of the root, and the surface of the gold and the root well polished.

"Thus far we have the root preserved with a good filling, and a gold tube firmly secured in it containing an accurately fitting gold pivot.

"The next operation is to attach a suitable tooth to the pivot, and for this purpose a plain plate tooth is selected that will be suitable in size, shape, and color. This tooth should be so ground and fitted to the anterior edge of the root that the free margin of the gums will cover the point of union. Then, after soldering a strong backing to the tooth, it is fitted to its position, with the gold pivot in place, on which has been soldered a small shoulder or ring of plate, and the projecting portion of the wire cut off. This shoulder is to be made in the form of a disc, cut out of gold plate, larger than the diameter of the pivot, then perforated with a hole just large enough to admit the pivot up to the point, a little less than the depth of the tube. Being retained at this point, it is made to fit closely down on the root; the whole is then carefully withdrawn and bedded up to the ring in plaster and asbestos, thoroughly dried, the wax removed, and the piece soldered with fine solder. If the ring is loose, it must be kept in place by wax or plaster in the act of withdrawing it from the tube. The pivot is again tried in the mouth and, if satisfactory, the projecting portion is cut off, smoothly filed, and the tooth attached to it with shellac; then try in the mouth, and alter its position if necessary. If the pivot does not fit too tightly, the whole can be withdrawn together, carefully invested in plaster and asbestos, and strongly soldered. The piece is now finished up, reducing the shoulder around the pivot to less than half a line in breadth; a large plate covering

the end of the root has no advantage, and would only form a lodgment for food and the secretions of the mouth, inducing decomposition and the destruction of the root.

"If the pivot is not retained sufficiently firm in the tube, it may be wrapped with a few fibres of floss silk or cotton, and when forced into its place with a slight rotary motion it will remain quite firm, and can be used with great satisfaction. If the adjustments have been properly made, the shoulder or flange will fit closely on the edge of the tube, the neck of the tooth resting on the beveled edge made for it, thereby preventing the tooth from turning on its axis. Proper care and cleanliness, removing the tooth at least three times a week, will enable such a piece to be used with satisfaction for many years."

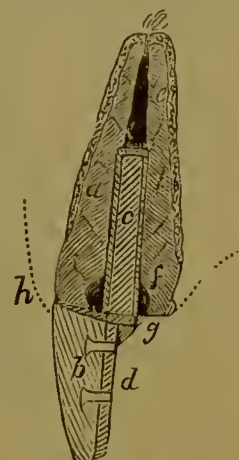


FIG. 628.

Fig. 628 represents an antero-posterior section of a superior central incisor root pivoted in the manner above described. *a*, dentine of root; *b*, porcelain tooth; *c*, pivot surrounded by the tube; *d*, backing, which is soldered to the tooth and to the pivot; *e*, filling between the end of tube and apex of the root; *f*, filling around the tube by which it is retained in place; *g*, flange resting on the edge of the tube; *h*, junction of the tooth and root, concealed by the margin of gum.

Another method for inserting an artificial crown on a metallic pivot is that of Dr. T. J. Thomas, by which the end of the root is protected from the action of deleterious agents and a firm support given to the tooth. It is thus described by Professor Gorgas:—

"Prepare the tooth as for an ordinary pivot; then select a *plate tooth* of the proper size, shape, and shade, and fit it by grinding accurately to the prepared root.

"After this is done, enlarge the pulp canal by reaming it out as large as the root will permit; that is, make a conical-shaped cavity in the exposed surface of the root, allowing the margin of this cavity to be quite near to the periphery of the root, with slight undercuts or retaining points on the anterior and posterior walls.

"After this cavity is prepared, and that portion of the pulp canal beyond it filled to the apex of the root with gold, make a square metallic pivot of twenty-carat gold alloyed with platinum, in the proportion of five parts of gold to one of platinum. This pivot is made in two parts, which are soldered together at the base of the artificial crown and slightly wedge-shaped. After the pivot is prepared, a thin piece of platinum plate is bent around it, thus forming a square cylinder into which the pivot perfectly fits. The pivot is then carefully

drawn out of the square cylinder, and the edges of this cylinder soldered with pure gold. The pivot is again inserted, and the excess of solder and any rough edges which may be found in the cylinder filed off.

"After this is done, the cavity in the root is carefully dried and protected from moisture, and the square cylinder, with the pivot inside of it, is placed in the center of this cavity, which is filled around it with gold in as careful and perfect a manner as any crown cavity, or secured by zinc cement. The gold, or the cement, is allowed to overlap the margin of the cavity, so as to perfectly protect all of the exposed—or what, in the ordinary method, would be the exposed—surface of the root.

"The gold filling, or cement, besides protecting the root, retains the square cylinder in the center of it. In placing the cylinder in the root with the pivot in it, preparatory to inserting the gold filling around it, if gold is used to secure the cylinder, the split in the pivot should range directly back from the labial to the palatine surfaces, and not transversely. The pivot, after the filling is inserted, is drawn out of the cylinder, which remains firmly fixed in the root, and that part of the cylinder which projects beyond the gold is filed down to a level with the surface of the filling. An impression of this surface is then taken with wax or gutta-percha, and die and counter die made of fusible metal, by means of which a disc of platinum plate is swaged to fit accurately the concave surface of the gold filling in the root.

"When this is done, the convex surface of the disc is thinly covered with wax, and the disc placed in its proper position over the gold filling in the root, and slightly pressed on it, in order to obtain an impression of the square orifice of the cylinder, by which a hole corresponding in shape and position may be cut in the disc. The outer end of the pivot is then inserted in the square hole made in the disc, secured by means of wax, and the whole returned to the root (with pivot in the cylinder), in order to make certain that the pivot is in its proper position; then it is carefully removed and secured by an investment of plaster and asbestos, that the pivot may be soldered to the disc.

"The projecting portion of the pivot above is filed down to a level with the concave surface of the disc, and the disc and pivot returned to the cylinder in the root, when the plate tooth is placed in position and secured to the disc by means of wax.

"This done, the pivot, disc, and the plate tooth are carefully removed and invested in plaster and asbestos, in order that a backing of gold may be made, and the tooth soldered to it and the disc. The tooth is now ready to be inserted, and by slightly separating the two parts which form the pivot, at its apex or free extremity, it will tightly

fit the cylinder, the two halves acting as springs, and pressing against the walls of the square cylinder inserted in the root."

The late Dr. M. H. Webb suggested several methods of pivoting by which gold crowns with porcelain faces made of plain plate teeth are attached to natural roots.

One of these methods consists in soldering to a plain plate tooth with straight pins a narrow strip of heavy gold plate beveled on its sides toward the tooth, and long enough to form the pivot extending into the root.

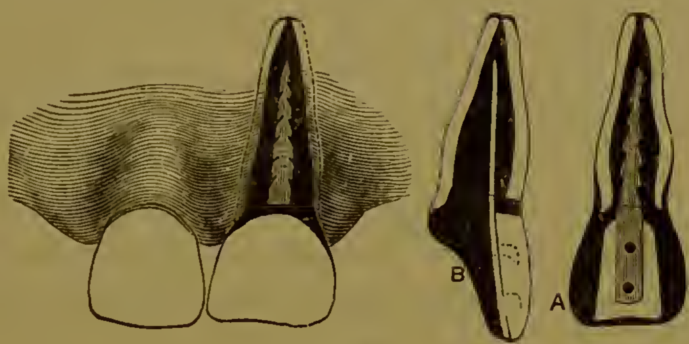


FIG. 629.

When ready for insertion, gold is packed around the pivot (being anchored in the roots by means of undercuts) and behind the beveled edges of the backing, and so built up as to form a contour palatine surface on the crown (Fig. 629).

Another method of Dr. Webb's is to back with gold plate a plain plate tooth with straight pins, the sides of the backing being bent to form a tube or cannula. Through this tube a gold pivot passes into

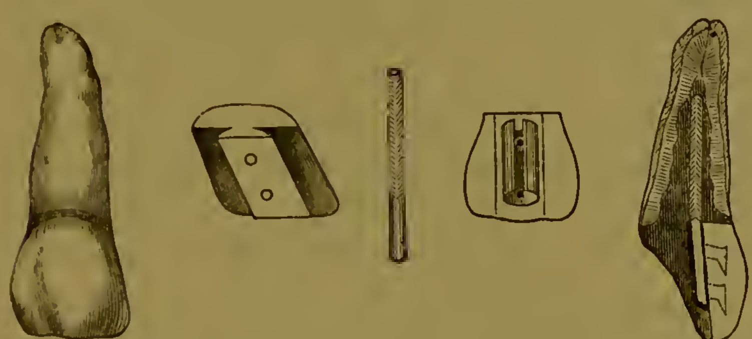


FIG. 630.

FIG. 631.

FIG. 632.

the root, and cohesive gold is employed to secure the pivot to both crown and root, by packing it around the pivot in the root, around the tube on the backing, and into the dovetailed grooves in the crown (Fig. 630). This plan is a modification of that suggested by Dr. W. H. Dwinelle, to be used in connection with crystal gold.

A method of no recent date is, to take an impression of the root surface and adjoining teeth, and to drill a hole in the plaster model thus obtained, to correspond to the canal or canals of bicuspids and

molars. Into these holes gold, platinum, or platinum-and-iridium alloy pins are inserted, and to these a disc covering the exposed surface of the root is soldered. A plate tooth is then adapted by grinding and soldered to the disc, the plaster model serving as a guide for the adaptation of both pins and crown. Fig. 631 represents the tooth prepared for insertion into the root by means of gutta-percha or zinc preparations, the pins being roughened or barbed, being made square for the latter purpose. When the roots are filled with gutta-percha, the pins and crown are warmed and pressed into place.

Dr. J. F. Flagg suggests the following method of pivoting, shown in Fig. 632, and described by him as follows: "Select plate tooth, fit it to root, and bevel it from near the pin—cervical—or pins, if cross-pins, to the labio-cervical edge. Solder a platinum pin to it as a backstay and pivot combined, leaving it rough or grooved on both sides of the pin for a retaining hold to the finishing palatal amalgam.

"Fill the root . . . . I prefer to give this ('cement') a day to harden thoroughly. In the root filling drill a hole larger than the platinum pin, as near to the palatal portion of the filling as possible, and directed slantwise to the apical center of root-filling; then fissure-drill the hole toward the labial side of the now *oval* pivot hole. By this method the tooth is accurately placed in position, and easily held firmly in place while the pin is secured by filling the pivot hole with amalgam. Let this harden for half an hour, and then add amalgam in contour to the root-filling and palatal face of the porcelain tooth. It is at this point of the operation that the need for 'beveling' the cervical portion of the tooth is demonstrated, for by this bevel one is enabled to make, by filling, a perfectly tight joint at the labio-cervical junction of tooth with root, and also to secure a strength of amalgam equal to the entire surface of root-filling."

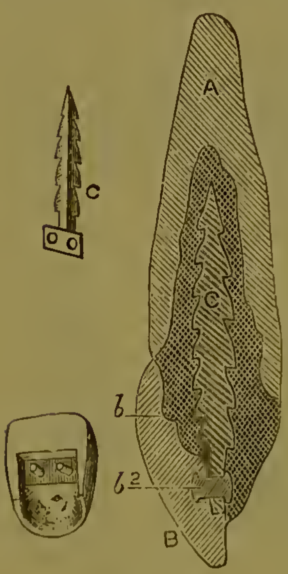


FIG. 633.

Dr. Boice modifies Dr. Flagg's method by cutting a groove across the tooth between the pins before attaching the platinum pivot, for the purpose of leaving a space behind the pivot for the better support of the amalgam with which it is filled.

Dr. H. Weston's method consist of a special crown with a depression on its palatal surface, within which are the tooth-pins and a spear-shaped pivot of hard platinum, or platinum-and-iridium alloy, notched on both edges, to the crown end of which a backing of the same metal

is soldered, giving the pivot with the backing (which is to be soldered to it) a T-shape (Fig. 633). The root canal being enlarged and undercut with a wheel-drill, and the crown fitted to the root and pivot, the latter is secured in the root by the packing around it, either amalgam, gold, or zinc preparation.

Dr. E. L. Hunter's method consists in making a pivot of gold alloyed with platinum, with a thread cut on one end, by means of which it is screwed into the root canal, the other end of the pivot being split. Several screws are inserted into the root around the pulp canal, to afford anchorage to the gold which is packed about them and the pivot projecting from the canal. A pivot crown being adapted to the root surface, the split end of the pivot is sprung open and the crown forced to its place, being firmly held by the split end of the pivot

Dr. G. P. Carman modifies Dr. Hunter's method by using an ordinary pivot crown, with the hole drilled completely through it (Fig. 634).

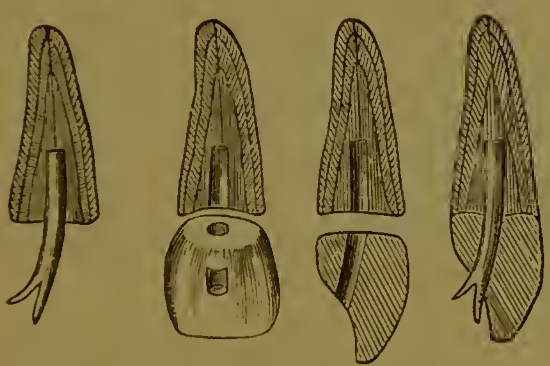


FIG. 634.

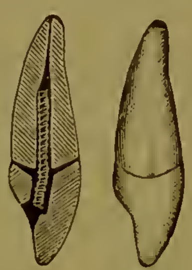
FIG. 635.

The split or cleft end of the pivot is made to fit loosely in the hole in the crown, so that gold may be packed around it to hold the crown firmly.

A method of pivoting devised by Dr. H. K. Leech (Fig. 635) is described also by Dr. Dexter, as follows: The root is drilled out to a depth of about three eighths of an inch, to a diameter of No. 16 standard American wire gauge, the bottom of the hole being flared or enlarged and the canal above filled with gutta-percha. A gold tube is made to fit the hole accurately and project sufficiently for convenience of handling, and is soldered through a hole in a gold base struck to the root, projecting through the plate some distance. A plate-tooth is fitted to the root and plate and soldered to the latter, gold being flowed on to the plate and backing and around the projecting tube, to form the palatal contour, and the tube cut off flush with the latter. We now have a plate tooth, gold backed, with a tube pivot,

the orifice of which opens on the palatal aspect of our tooth. The root end of the tube is now slit perpendicularly in three or four places, for about two-thirds of its length, a thin sheet of warm gutta-percha is placed on the base of the crown around the tube, and the whole is pushed securely to place. Now pack gold or tin into the tube, *condensing the bottom portions so that the slit end will spread and tightly fill the flared end of the hole in the root*, and the operation is complete. Dr. Dexter suggests that tin be used to fill the tube, so that the tooth may be easily removed in case of trouble.

Dr. W. G. A. Bonwill, the inventor of the "Bonwill crowns," has suggested several methods of pivoting, but the latest, consisting of an all-porcelain crown, he considers to be the best. These teeth are made in special molds, and the incisor crowns are so shaped as to form a dovetail, which allows the strain outward to come high up near the cutting edge, and not to depend upon the palatal wall for support. The bicuspid and molar crowns are cut out at the base, leaving little more than a shell with undercuts for the amalgam, to act as dovetails, the operation being an amalgam filling capped with porcelain. The hollow crowns enable the operator to fit them to the natural roots very readily, as there is little material to grind off.


Mounted Crown.

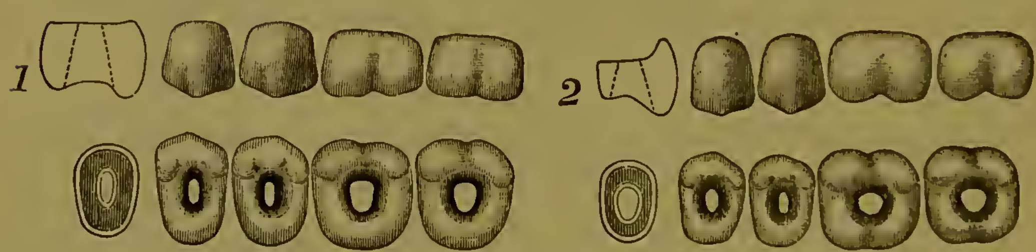


Fig. 636.

After the crown is fitted to the root the pulp canal is filled with amalgam in a plastic condition, and the triangular barbed metal pin is forced into it. The crown is then filled with the same substance, placed over the pin, and forced to its place, the pin resting in the hole in the crown. Several modifications of this method are suggested by the inventor, such as a nut on the end of the pin, and a gas vent formed by allowing a flat side of the pin to rest against one wall of the canal, and the space kept free of amalgam when it is packed about the pin. Retaining points are made in the root with a wheel bur, and the amalgam is packed in the countersunk base of the crown, and

the surplus escapes by the opening on the palatal surface in the case of an incisor crown. When the crown is well pressed into its place on the root, the amalgam can be packed in around the pin. The too free escape of the amalgam through the palatal opening in the crown can be prevented by placing the thumb and index finger on the orifice when pressing up the crown. The tooth should be kept at rest until the amalgam has hardened. Fig. 637 represents the Gates-Bonwill

FIG. 637.

crowns, which are inserted on the triangular pins in the same manner as the crowns just described.

Dr. S. Davis's method (Fig. 638) is to prepare the root as usual, and ream out the chamber in a funnel shape, and cut anchorages in the sides of the reamed surface. A plate-tooth is then fitted, by grinding it, to the labio-cervical edge of the root, and backed with gold plate, when the sides of the tooth and backing are ground to bevel sharply inward, leaving the labial surface untouched. A gold pivot is then soldered to the backing, of such a length that when it is placed in position a narrow space is left between the crown and root. The pivot and backing are then roughened, the latter being barbed and fastened into the root with oxychlorid or oxyphosphate of zinc. Gold is then packed in the retaining points, the pulp chamber and around the pivot, and built upon the backing to give a proper form to the inner surface of the crown of the tooth.

The four-pin crowns, invented by Dr. W. Storer How, are among the more recent methods of pivot work, and the following description of the successive steps to be taken in mounting these crowns, with the necessary appliances, was prepared for the present edition of this work by Dr. How.

1. When the root is in proper condition for mounting, measure the depth of the canal by means of the canal plugger (Fig. 640) and its flexible gauge (Fig. 639), and fill the canal at and a short distance from the apex of the root, keeping the gauge at position to show the length of the canal, and also the distance to which it has been filled.

2. Cut off the root crown, with the excising forceps and a round file, down to the gum margin, and with the barrel bur, No. 241, cut the labial part of the root fairly under the gum without wounding it.

3. Set gauge (Fig. 639) on a Gates drill (Fig. 644), to one-half the gauged depth of the canal, and drill to that depth.

4. Set the twist drill (Fig. 643) in its chuck (Fig. 647), to project the same length as the Gates drill, and, turning the chuck with thumb and finger, drill the root to exactly that depth.

Fig. 638.

Fig. 641.

Fig. 642.

Fig. 643.

Fig. 639.

Fig. 645.

Fig. 646.

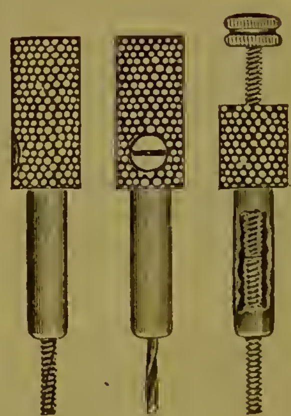


Fig. 647.

Fig. 640.

Fig. 644.

5. Enlarge the mouth of the canal, one-sixteenth of an inch deep all around to near the margin of the root, using the square-end fissure

bur, No. 59, and then with the oval, No. 94, under-cut a groove at the sides and lingually, as shown in Fig. 645.

6. If the rubber dam is to be used for a gold or plastic backing, put it now over the root with Hunter's root-clamp, also over the adjacent teeth, and thoroughly dry the canal.

7. Set the tap (Fig. 646) in its chuck (Fig. 647), a trifle less in length than the drill; oil the tap and carefully tap to the gauge depth.

8. Insert the post in its chuck (Fig. 647) to the exact gauge of the tap, and turn the thumb screw down hard on the end of the post; then screw the post into the root; release the thumb-screw; unscrew the chuck a half turn; bend the post until the chuck stands in center line with the adjoining teeth, and unscrew the chuck.

9. Slit the rubber back from adjacent teeth, tucking the flaps out

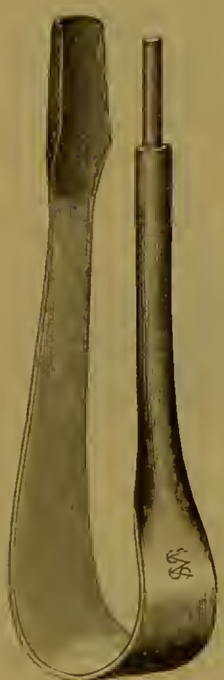


FIG. 648.

FIG. 649.

FIG. 650.

FIG. 651.

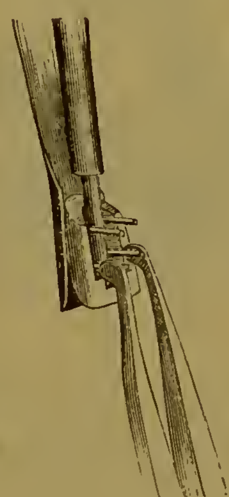


FIG. 652.

FIG. 653.

FIG. 654.

of the way, so that occlusion may be tried, and the post excised and ground off, until the teeth close clear of the post.

10. Try the crown on the post, and with an F disc, *dry*, grind the rib between the neck-pins until the crown is labially flush with the root margin, cutting a little at a time until exactly flush.

11. Take the crown and place the mandrel (Fig. 648) between the pins just as the post is to be, and, with the pliers (Fig. 649), bend the pins carefully over the mandrel, cutting off the pins if too long to be pinched in on the mandrel at the sides, observing that the pin nearest the cutting edge is first to be bent (Fig. 651), and the opposite pin bent *below* it on the mandrel, and so with the others (Fig. 652).

12. Slip the crown over the post, try occlusion, and with the post-chuck bend the post until the crown is properly aligned with the teeth; then with a stump corundum wheel No. 3 grind the neck of the crown to a close labial fit with the root, fitting only the portion to be concealed by the gum, leaving narrow gaps at the sides to be filled by the backing between crown and root (Fig. 653).

13. Grind the cutting edge for relation to the other teeth, being sure that the opposing tooth does not strike crown, or post, or pins.

14. Fix the crown on post by pinching the pins into the screw threads of the post with special pliers (Figs. 649 or 650).

15. Finally, pack the backing of gold, or cement, or amalgam, or Wood's metal, or—for temporary backing while treating abscess—gutta-percha, into all the crevices around the post and behind and under the pins, and between the crown and the root; contour and finish thoroughly, so that no ledge or other imperfection can be found.

Fig. 654 shows in vertical mid-section an incisor crown mounted; the blackened portions of the backing defining the locking-hold of the backing on the post, the crown-pins, and the root recess.

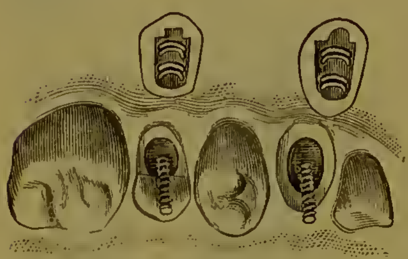


Fig. 655.

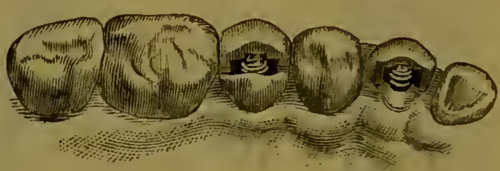


Fig. 656.

Fig. 655 shows in perspective a cuspid crown ready to be slipped over its post, and also a cuspid crown ready for its post in the bicuspid root, which has its lingual cusp remaining, and Fig. 656 shows the crowns on their posts awaiting the contour-backing.

In mounting a crown on the bicuspid root (Fig. 655) the chucks will not usually pass the natural cusp, and hence the drill and the tap must project the cusp's length in addition to the gauge length. Observe also if the space between the tap and the cusp is wider than the thickness of a crown-pin, and, if not, cut the cusp vertically with a large fissure-bur, so that the space shall be wide enough, before setting the post, else the bent pins will not pass between the post and cusp. Grind the rib—see step 10—quite down to the floor of the crown; take steps 11, 12, and 13, and, if the occasion necessitates grinding the crown so as to destroy one pair of pins, invest the crown, and older the pins at the lap, taking step 15 for completion.

When it is desired to contour the backing of a cuspid crown to

form an inner cusp, or to adapt a cuspid or incisor crown for masticating uses, the pins may be twisted together over the mandrel, and again twisted tightly over the post, as in Fig. 657; but in some cases it may be better to bend the neck-pins, as in Fig. 658, instead of twisting them. In all cases the bent pins are to be pinched quite hard over the mandrel and post, so that the serrations of the pliers will roughen the pins to prevent their being pulled through the backing, which should also be condensed around the pins and post.

If the root is not ready for permanent mounting, use a tubular post, or, in the absence of a threaded tube, take the successive steps up to 13; then back temporarily with wax, rubber, or gutta-percha, awaiting the next sitting, when the crown may be taken off, the post unscrewed, and the remedy applied. Thus the root may be alternately medicated and mounted until ready for the permanent crown.

When the root is much decayed, the bottom of a cone-shaped

FIG. 657.

FIG. 658.

FIG. 659.

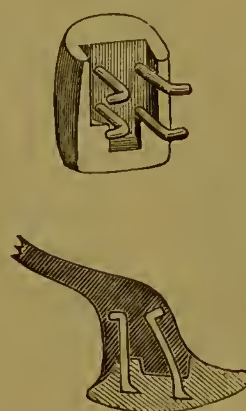


FIG. 660.

cavity may be drilled and tapped to the depth of a sixteenth of an inch, and the post, thus anchored, may be further secured by cement in the grooved walls of the cavity and around the post (Fig. 659).

These crowns afford unusual facility for mounting by any of the well-known methods of inserting the post after soldering it to the crown. They are also adapted for use in celluloid and rubber work, especially in cases of single teeth. The several long pins, having their ends bent with pliers at a sharp angle (Fig. 660), may be so arranged as to both strengthen the shank of the plate and hold the crown very firmly in position.

The screw-posts are made of crown metal, an alloy devised for the purpose, in order to obtain a stiff post that will permit the cutting of the peculiar and extremely accurate thread formed upon it, and which will not amalgamate or be otherwise affected by any backing material that may be used. Of course, platinum or platinum alloyed with

iridium may be employed for posts, but the crown metal is in every way superior.

There are some cases of a class which has hitherto presented difficulties that may now be easily overcome by grinding the post flat on the crown side after it has been set and bent in the root (Fig. 661),

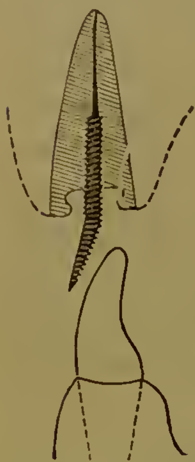


Fig. 661.

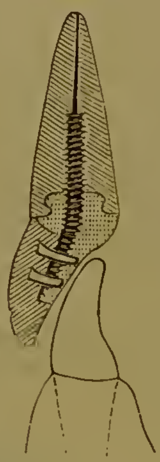


Fig. 662.

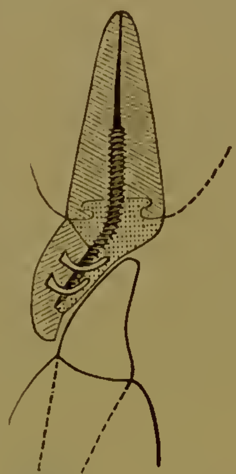


Fig. 663.


Fig. 664.

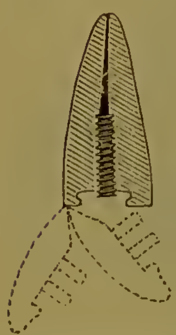


Fig. 665.

so as to be clear of the occluding tooth; and then the crown-pins may be bent over the reduced post, the crown fitted and ground to clear the opposite tooth (Fig. 662), and the backing added.

A similar case, in which the opposing tooth and a proper alignment require an oblique bending of the pins, is seen in Fig. 663, while the reverse arrangement of parts is shown in Fig. 664. The crown is thus seen to be adapted to a wide range of adjustments because its point of contact with the root is at the labial portion of the neck, on which, as on a hinge, the crown may be swung out or in (Fig. 665, dotted lines), over an arc of at least sixty degrees, at any point of which it may be quickly and firmly fixed. The labio-cervical

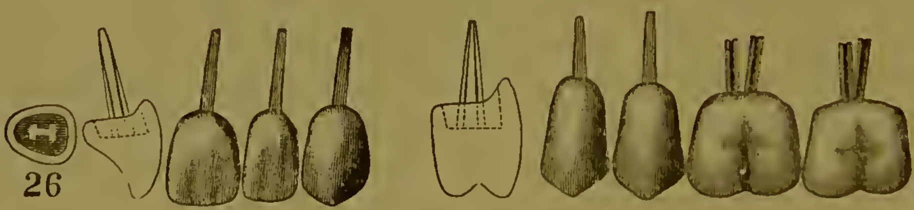


Fig. 666.

junction is made just under the gingival margin, with a thin layer of cement, amalgam, or gutta-percha, or a narrow ribbon or several large blocks of soft gold interposed; the joint always to be made smooth, and hid from view under the free margins of the gums.

Dr. M. L. Logan has devised a porcelain crown, with a metal pin placed in position before burning the tooth (Fig. 666). The pin extends three-eighths of an inch outside the crown, which is provided with a basal cavity intended to be filled with a cement or other retaining material, to afford additional support.

Fig. 667 represents posterior Logan crowns, where the pin, in the incisors, cuspids, and bicuspids, is a stout, tapering, double-T-shaped platinum post, which extends outside of the crown three-eighths of an inch. It can be split, as shown, for two-rooted bicuspids, or shortened when necessary. The molars are made with two square pins, grooved on all four sides. One of these is for the palatal root, the other for either of the buccal roots, as may be most convenient. The posts can be filed smaller for special cases, or nicked, if desired, to afford a stronger hold in the retaining material, though this will usually be unnecessary, as their shape was designed specially to give the strongest hold possible. It can be used with the seamless gold collars when desired.

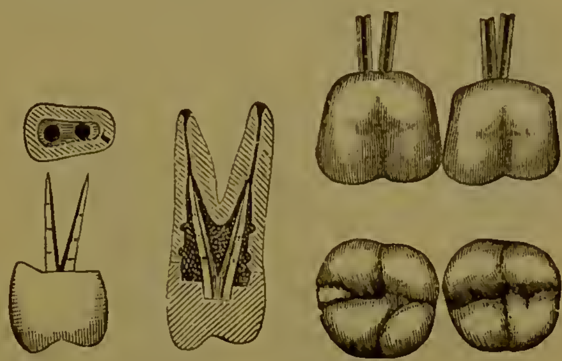


FIG. 667.

For reaming out and grooving the walls of the root-canals, Fig. 668

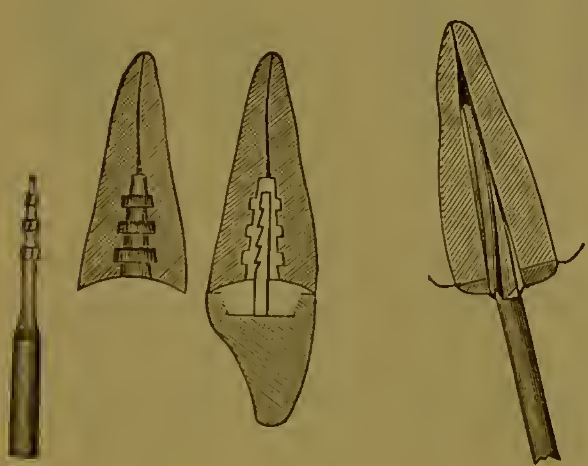


FIG. 668.

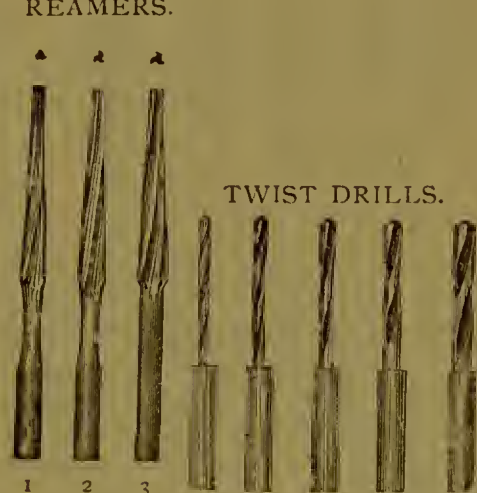


FIG. 669.

represents what is known as the "grooving bur engine-bit." This bur is intended for cutting grooves in the walls of root-canals to provide retaining-points for plastic materials in setting porcelain crowns. The grooves are made by sweeping the bur, while in motion, around the walls of the canal, which should be made large enough to permit the bur end to reach the bottom of the cavity. Two or three grooves,

as may be desired, can be cut in thin roots with safety, one size of the bur answering for all cavities. The canal is then filled with gutta-percha, oxychlorid, amalgam, or other plastic, and before it sets the barbed pin of the crown is inserted, with the effect of forcing the material into the grooves, thus adding greatly to the strength of the operation.

Fig. 669 represents twist drills and root-reamers.

Fig. 670 represents Dr. Ottolengui's root-facers, and Fig. 671 represents corundum points for dressing and beveling roots.

The root-reamers are of the size and taper of the Logan crown-pins Nos. 1, 2, 3, and have corresponding numbers. With a drill just the diameter of the smooth end of the reamer, the root should be drilled to the proper measured depth and the bored canal be then enlarged

ROOT-FACERS.

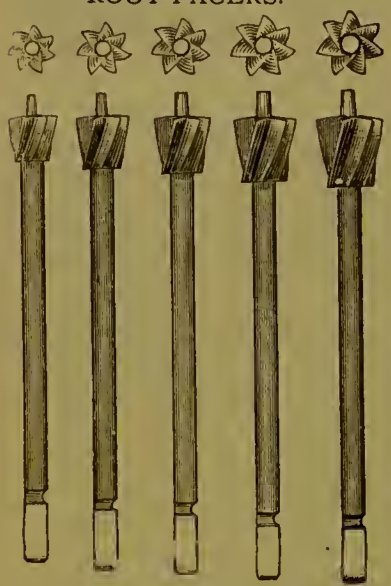


Fig. 670.

ROOT-DRESSERS.

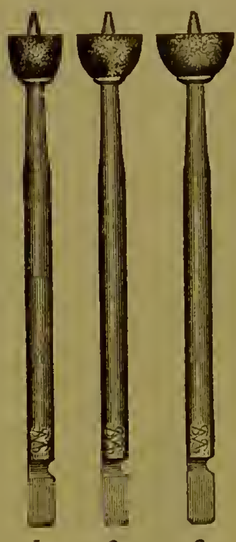


Fig. 671.

Fig. 672.

Fig. 673.

with a suitably numbered root-reamer, which, having a smooth end, cannot be forced beyond the end of the drilled hole. There are five sizes of the root-facers, so that one may be chosen of such width that the root end can be smoothly, quickly, and safely faced to fit the crown.

Dr. R. Ottolengui's method of mounting the Logan crown is as follows: "The canal of the root to be crowned is opened up to the proper depth with a twist drill, and then with a root-reamer corresponding to the size of the pin, is enlarged to fit the pin along its whole length, and so hold the crown firmly *independently* of the cement. With a root-facer a labial slope is given to the root-end, so that the crown neck shall fit under the edge of the gum. The cuts (Fig. 674) show the method and its result, and the cross-section shows how the cement encases the pin.

"The distinguishing excellences of this crown are the ease with which it can be set and the naturalness and strength of operations made with it. The crown is hollowed out around the pin so that when mounted the retaining material extends inside of the crown instead of forming a joint at its junction with the root, thus carrying the line upon which the leverage is exerted nearer to the point upon which the biting force is applied, and providing room for a considerable body of the retaining material instead of a thin disc as

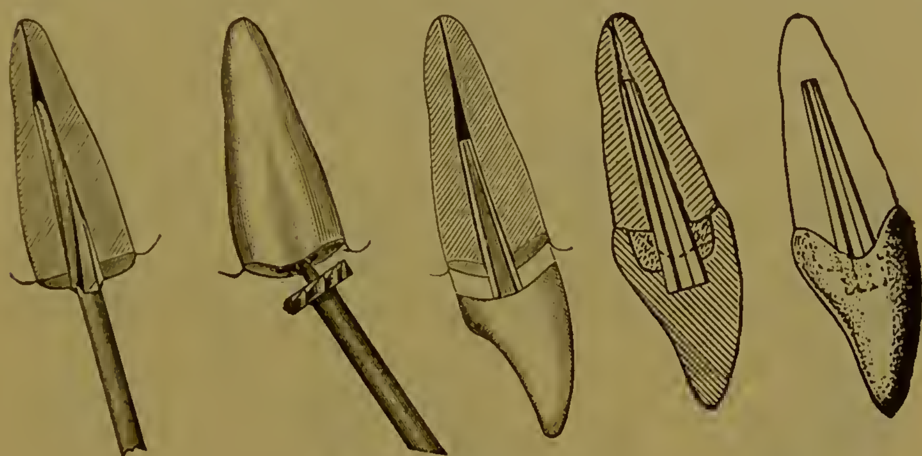



FIG. 674.

in ordinary crowns, reducing the liability to fracture to the minimum."

Fig. 675 shows an enlarged platinum pin, and also a cross-section of a central incisor, giving the position of the pin in the root.

Dr. Gordon White's method of adjusting a Logan crown to a natural root is as follows:—

"By making a considerable change in the present form of the Logan crown, as shown in Fig. 676, A and B, we have a crown that can be adjusted in a few minutes, and with a degree of perfectness not yet obtainable by any crown on the market, nor, within my knowledge, by any so far suggested method.

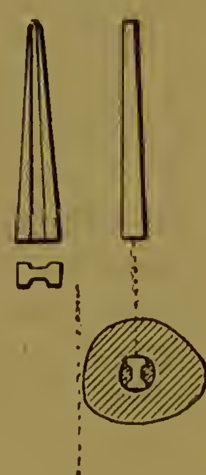


FIG. 675.

"The manner of making the adjustment is certainly as simple as could be desired.

"After preparing the canal for the reception of the 'Logan-pin' select a tooth in the usual way, having regard to correct length, width and color, and if care has been exercised to select one as near the right length as possible it will only be necessary to touch the buccal or labial point of the neck of the crown a few times with the corundum wheel, and the proper length or bite will be obtained. Next take a disc, or small piece of

thin platinum foil, about No. 50, and push through this the pin of the tooth, carrying the disc up against the porcelain, as represented in Fig. 677. With a little drop of Parr's fluxed wax dropped in the triangle, as it were, formed by the backing and the pin, the disc is held securely in place, and the platinum is trimmed around with small scissors, that there may not be any overlapping. Now place around the pin on the platinum a ball of Parr's wax, stick the pin through the second disc of the foil, and rub the platinum with a hot instrument, that the wax and disc may be sealed together, as shown in Fig. 678. Place this in ice-water to harden the wax, so as to resist pressure. It is now ready to insert, and by pressing the tooth up until the labial surface strikes the end of the root, and having the patient to close the jaws, the correct bite will be secured with the opposite tooth. It will be found on the removal of the crown, that the platinum next the root has been perfectly swaged to the root-end. The second disc is now trimmed according to the outlines of the root. When it is so desired, the palatine side of the root having been left a little high, or just above the

FIG. 676. FIG. 677. FIG. 678. FIG. 679. FIG. 680.

gum, the platinum can be split with scissors, lapped, and burnished around the exposed side of the root, to form a partial band (Fig. 679).

"After having dried the wax with bibulous paper, and shaped up the approximal sides, these sides are covered with small, triangular pieces of platinum (Fig. 680), by laying the platinum on the wax and rubbing over it a hot burnisher. The crown is now ready to invest, and the investing mixture is poured on a small piece of wire netting, which will prevent its cracking during the soldering operation. The wax having been burned out, this triangular box is filled flush with solder in the usual way and polished. The result is a beautiful and perfect crown, in every respect the most substantial porcelain crown we have."

Dr. E. C. Kirk's method of fitting the same style of crown is as follows:—

"The following method will in the majority of cases enable a perfectly close joint to be made between the crown and root-end. Cut several small pieces, about one-quarter inch square, from a strip of thin articulating paper. In the center of each punch a hole with the tool shown in the margin. Having prepared the root-end, slip the

perforated piece of articulating paper over the pin of the Logan crown and press it firmly into position, in contact with the root. Upon withdrawing the crown and removing the articulating paper, the points of contact will be found to be marked black. Grind these off carefully, readjust on the root as before, grind again, and continue the operation of fitting and grinding until the mark made by the articulating paper on the contact surface of the crown presents as a uniformly unbroken black ring. When this has been accomplished, the crown will be found to fit the root-end with the utmost accuracy. The advantages of fitting a crown directly to the root are, it would

Punch for Making Holes in Articulating Paper.

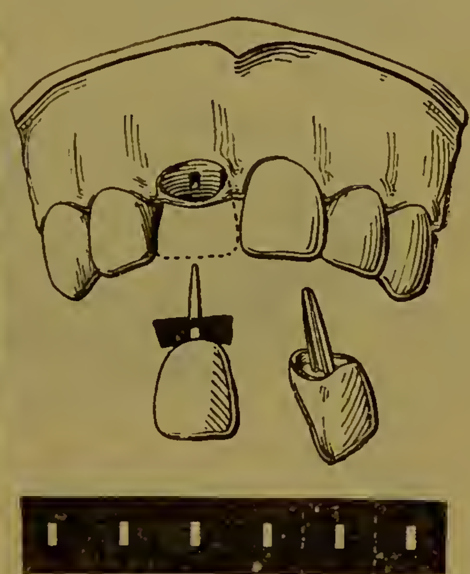


FIG. 681.—Prepared Articulating Paper.

FIG. 682.—The above figure shows the Operation of grinding the Crown to fit the Root.

seem, self-evident from the mechanical standpoint, and involve beside the least expenditure of time."

Another method of fitting the same crown is as follows:—

"After preparing the root for the reception of the Logan crown in the usual manner (Fig. 683), take an impression of the end of the root and surrounding parts with the proper quantity of moldine in a partial impression tray (Fig. 685). Remove the impression carefully and fill it with Melotte's metal. The location of the root canal will be clearly indicated by a small hole in the metallic model (Fig. 684), and this hole may be deepened with a twist drill and slotted or elongated for the reception of the crown pin with an Ottolengui reamer. This gives a metal root,—the exact counterpart of the natural one and adjacent teeth,—by which the crown may be fitted."

Dr. T. P. Hinman's method is as follows (Fig. 686):—

"First prepare the face of the root to be crowned as desired (Fig. A), and having selected a suitable crown (Fig. B) bend the pin, if necessary, so as to make a proper alignment.

"Next place a piece of paraffin wax around the pin next to the porcelain (Fig. C), then take No. 60 tin foil and trim a disc a little larger than the abutment (Fig. D), pierce the center of disc with the crown-pin or instrument shown in margin (Fig. E), pushing disc down until it touches the wax, place crown on the root, and force it to place (Fig. F), the wax driving the tin-foil disc to a perfect apposition with the abutment of the root.

"Remove crown with the wax holding the tin-foil disc in position, and with a pair of sharp-pointed scissors snip the edges of disc slightly all around. Place a small pellet of wax on end of pin (Fig. H), then insert pin up to the porcelain in quick-setting plaster (Fig. I); after plaster hardens warm crown and remove it, the snipped edges of disc

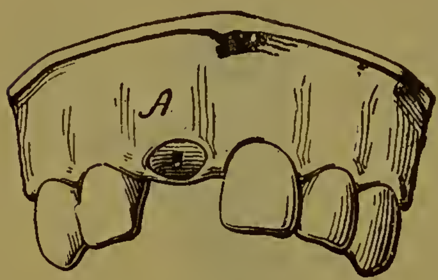


FIG. 683.

FIG. 684.

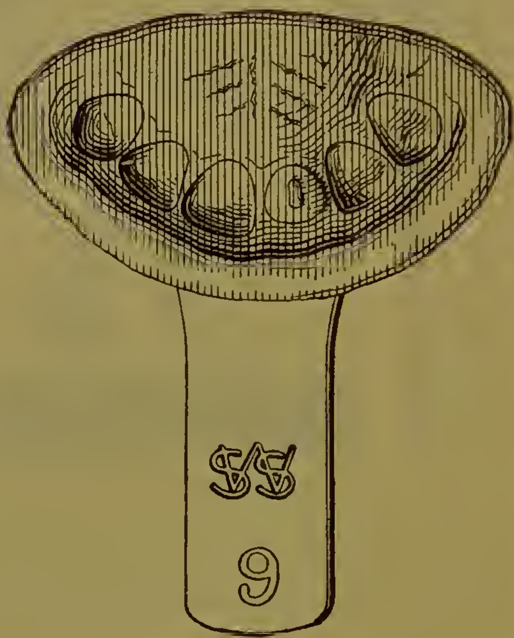


FIG. 685.

serving to hold it in position; clean off wax and replace crown on model, and you have a perfect metallic-surfaced model of the abutment of the root to which to grind with a perfect view of every surface of the root, the wax which was on the end of the pin allowing it to penetrate the plaster as the porcelain is ground away. By this method a Logan crown can be made to fit perfectly in ten minutes and no guesswork (Fig. K). It is also applicable to bicuspids."

To mount a Logan crown with gutta-percha, the following is the method (Fig. 687):—

"First prepare and treat the pulp-canal of the natural tooth-root in the ordinary way, the canal being provided with undercuts or retaining points, and fit the crown in proper alignment with adjacent teeth as usual. Fill the cup or recess in the neck of the porcelain crown

with gutta-percha, which can best be accomplished by slipping a washer or perforated disc of gutta-percha, cut to correspond approxi-

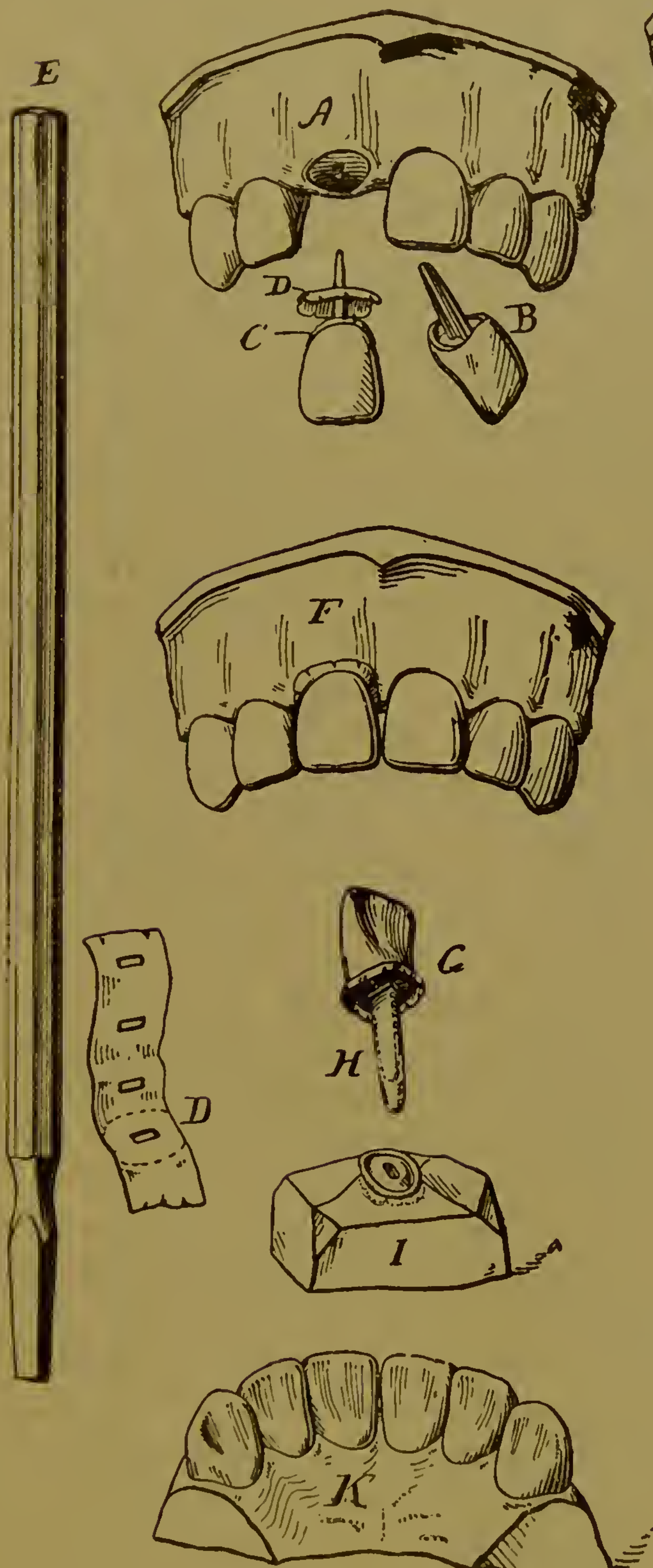


Fig. 686.

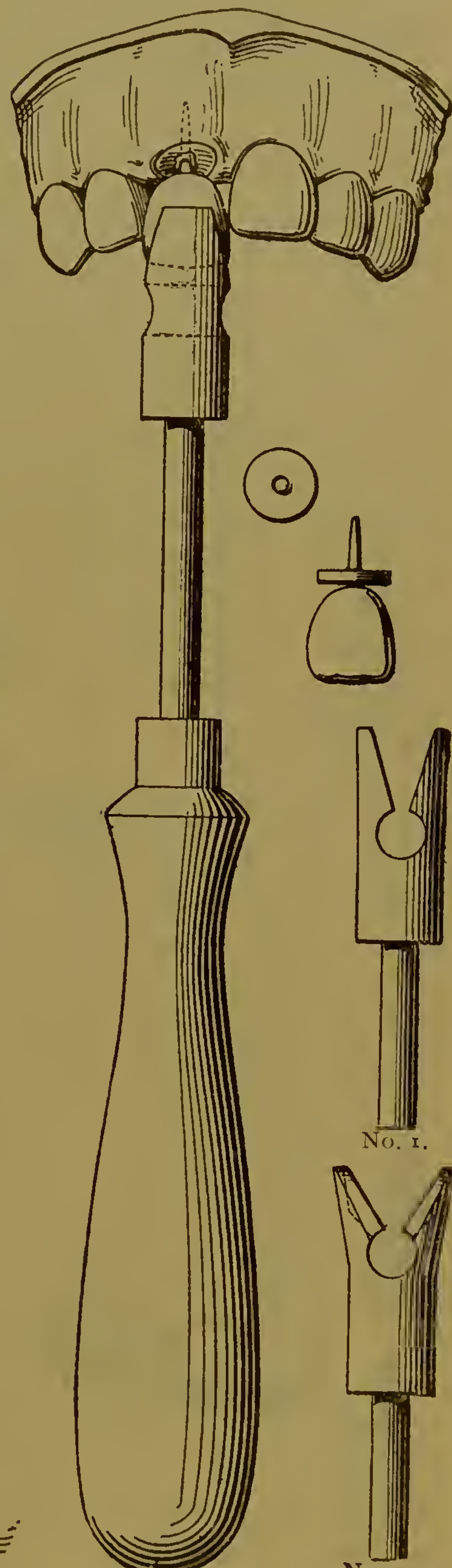


Fig. 687.

mately with the size of the neck of the crown, over the crown-pin, and after softening by holding it in the flame of a burner, press the crown

to its place upon the root. After it has been held in position until the gutta-percha has cooled, remove the crown from the root and trim off any surplus gutta-percha. Now coat the end of the root with shellac varnish, fill the root-canal with a suitable amalgam or cement, or if preferred pack it with prepared gutta-percha points, using such an amount of points as will allow the crown-pin to enter the canal quite the full length of the pin. The opening for the pin in the gutta-percha in the canal may be made with a heated instrument having a tapered point. Having packed the crown-recess with the proper quantity of gutta-percha, as above explained, place the crown in position in the mouth, heat the copper end of a crown-setter sufficiently to soften gutta-percha, and place the grooved end of the setter over the crown with the heated copper in contact with the porcelain. Hold the setter against the crown until the gutta-percha becomes soft, when pressure should be applied to the setter and the crown with its pin forced to its proper position. After the gutta-percha becomes cool, which can be hastened by dipping the crown-setter in a tumbler of ice-water and holding it against the tooth until it is cold, cut off any surplus that may be squeezed out from between the crown and root, with a sharp knife, and then with a hot tool smooth the edge of the gutta-percha between crown and root. If the cutting is attempted while the gutta-percha is soft, it will be dragged out of place.

"The use of gutta-percha for packing the root-canal, thus making the entire attachment with this material, possesses the advantage over the use of cement or amalgam, in that, should the root become abscessed, the crown may be removed with a pair of forceps after first heating it with the setter, the root-canal treated until the disease is cured, and the crown reset. Heating the porcelain crown when a cement is used to fill the root around the pin hastens its setting. Do not heat the crown if amalgam has been used.

Fig. 688.

"A bridge made with Logan crowns instead of plain teeth is simple of construction as well as strong (Fig. 688). Each crown is prepared by cutting off the cervico-lingual wall of the basal cavity, and placing a packing soldered to the pin over the entire cervical end. They are then assembled as a bridge, invested in plaster and sand, the backings soldered together, and the pins, except those used for anchorages, cut off. A root for anchorage is banded and its end is covered with a plate with a hole through it for the passage of the pin."

To grind the Logan crown it is suggested to take a hollow mandrel and, while in a hand-piece, heat the end and mount on it a corundum or carborundum wheel, such as No. 00, being careful to make its outer face true, and to leave the hole in the end of the mandrel free for the post of the crown to enter. The neck of the Logan crown can then be ground without the risk of grinding the post, which enters the socket of the mandrel and is protected.

A crown has been invented by Dr. Richmond, and the mode of mounting it is described by Dr. How as follows:—

"A superior central incisor root will serve as a typical case, and its projecting end is to be shaped as seen in Figs. 689 and 690. This can be rapidly done with a narrow, safe-sided, flat, or square file, the angles of the slopes being such that the gum on the labial and palatal aspects will not interfere with nor be disturbed by the operator in this preliminary work, for the root-end is not at this time to be cut quite down to the gum. A root-reamer is then employed to bore out the root to receive the crown-post, which is of the same size and shape as the Logan crown-post for a central

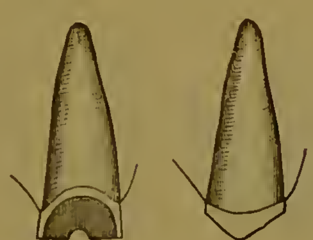


FIG. 689.

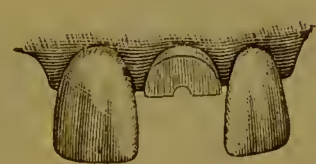


FIG. 690.

FIG. 691.

incisor. Fig. 691 shows in section the relation of the reamer to the root. The Richmond crown, Fig. 692, is then put on the root (see Fig. 693), and its position relative to the adjacent and occluding teeth noted. If the cutting-edge of the crown is to be brought out for alignment with its neighbors, the root can be drilled a little deeper and the reamer pressed outward as it revolves to cut the labial wall of the cavity. The palatal root-slope must then be filed to make the V correspond to the changed inclination of the crown.

"Thus, by alternate trial, and reaming, and filing, the crown may be fitted to the root and adjusted in its relations until the post has a close, solid bearing against the labial and palatal walls of the enlarged pulp-cavity, and the crown-slopes separated from the root-slopes by the thickness of a sheet of heavy writing-paper. This space can be accurately gauged, and the root-slopes conformed to the crown-slopes by warming the crown and putting on its slopes a little gutta-percha, so that an impression of the root-end may be taken, and the root-slopes dressed with a file until the film of gutta-percha proves to be of equal

thinness on both slopes. After thus completing the adjustment, with due attention to the alignment and occlusion, the crown and the root are to be dried as thoroughly as possible.

"To do this effectively in the root, it should first be swabbed and washed out with absolute alcohol, and then continuously flooded with warm air, until the root is not merely dry, but dried throughout as far as possible, and made so warm as to render the patient conscious of its heat. A little gutta-percha is then put on the sides of the post and over the slopes of the crown, which is then pushed into place, the exuding gutta-percha cut away, and the joint smoothed with a warm burnisher. The film of gutta-percha should be *very thin.* The crown and root may be quickly cooled by the use of the syringe with cold water, and the patient then enjoined to let the crown rest for a few hours in order that the gutta-percha may become quite set. Fig. 694 shows the completed crown.

"Dr. Richmond usually takes a thin, perforated disc of gutta-

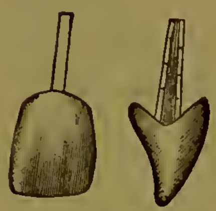


FIG. 692.


FIG. 693.


FIG. 694.

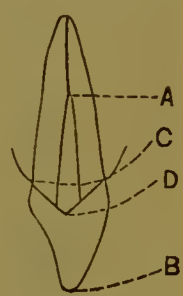


FIG. 695.

percha, pushes the post through it, warms the crown, presses it into place, and when cooled removes the crown, and with a sharp knife trims away the gutta-percha close to the crown-neck. He then warms the crown, puts a very little oxyphosphate cement on the post, and presses the crown home.

"The obvious advantages of the device are: the readiness with which the slopes of the root end may be shaped with a file; the facility with which these slopes may be given any angle to set the crown out or in at the base or at the cutting edge, or to give it a twist on its axis; the certainty that, once adjusted, the final setting will exactly reproduce the adjustment; the assurance that in use the crown will not be turned on its axis,—a most common cause of the loosening of artificial crowns; the firmness of its resistance to outward thrust in the act of biting. This fact is made apparent by Fig. 695, wherein it will be seen that in an outward movement the crown B would rock upon A as a pivot, and the dotted line D shows how the crown slope is resisted by the root-slope, which extends so far toward the incisive edge that a

much firmer support is given to the crown than if the resistance should be, as it usually is, on the line of the gingival margin C.

"The cases for which the new crown seems specially adapted are such as have some considerable portion of the natural crown remaining, and for these it would seem that no better artificial substitute has yet been made accessible to the profession.

"For roots that have become wasted below the gum-surface the new crown is not suitable, except in such cases as are decayed under the labial or palatal gum-margin only, but have yet projecting the approximal portions of the crown (see Fig. 696).

"The sectional view (Fig. 697) and the perspective plan views (Fig. 698) illustrate the manner of mounting these crowns on this class of roots. The finished crown appears as in Fig. 698."

Fig. 699 represents different forms of crowns, and the nut-driver and screw-nut for setting porcelain crowns on natural roots.

The all-porcelain crowns, such as the Foster, Gates-Bonwill, dove-

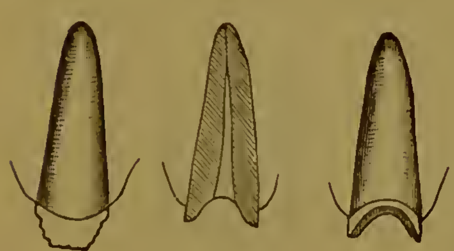


FIG. 696.

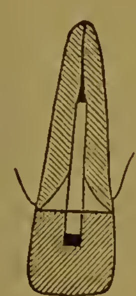


FIG. 697.

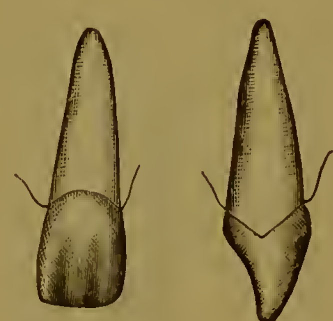


FIG. 698.

tail crown, and others, have been set in various ways, prominent among which has been the use of solid-headed screws; but we find that much more satisfactory and firmer work can be done by first fixing the screw-post in the root, thus permitting the crown to be slipped over the end of the post and properly adjusted to the root, after which the cavities in both root and crown may be partly filled and a nut screwed on the end of the post to condense the filling and firmly secure the crown in its place. These appliances are very simple. They consist of a nut-driver, over which is placed a split tube for carrying the nut (see sectional view). The sole object of this tube is to hold the nut and prevent its falling into the mouth or on the floor during the process of attaching or detaching it from the post.

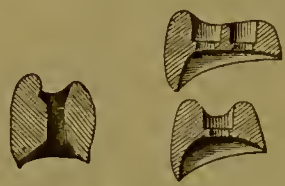
The substitution of pieces of porcelain for the portions of crowns of teeth destroyed by caries, by a process of inlaying, was suggested many years ago by Dr. Edw. Maynard, and successfully practiced by

Dr. A. J. Volck, of Baltimore, and also by Dr. B. Wood. Dr. W. Storer How describes a method as follows:*—

"One of the chief obstacles to success in many of these operations has been the difficulty of exactly fitting the inlay to the tooth. There is, however, a class of cases which, by methods that will be now described, may be repaired with the certainty of gratifying results.

"A typical instance is that illustrated in Fig. 700; the filling of gold usually inserted in such a cavity is a glaring disfigurement,

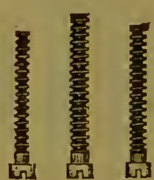
Foster Crown.



Gates-Bonwill Crown.

Dove-tailed Crown.

A B C
How Screw Posts
(B with nut).



A B C
Headed Screws.

Nut-Driver with Split Tube.
Fig. 699.

endurable only by reason of the necessity of preserving the life and usefulness of the tooth. Fig. 700 also shows the oval-shaped cavity about to be converted into a circular one by means of a wheel bur, as, say, No. 208. A fine-cut bur is essential for this work, which requires skill and delicacy with firmness of touch in order to the making of a truly circular cavity of the smallest diameter consistent with the inclusion of all the borders of the original cavity. When

* *Dental Cosmos*, August No., 1888.

this has been nearly done, and the cavity suitably deepened by an excavating wheel-bur, as No. 22, the barrel-bur, say No. 239, is to be used with steadiness and due attention to the holding of it, so that when pressed quite to the bottom of the cavity the margin will be exactly circular, whenever that is possible. (See Fig. 701.) In some cases the differences between the diameters of the successive or even the same numbers of the finishing burs will be found too great, so that while one size is not quite large enough, the next size is much too large. It is best, therefore, to be prepared with some hard-wood

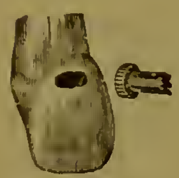


Fig. 700.

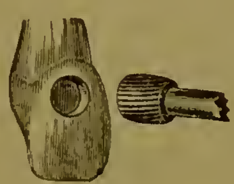


Fig. 701.

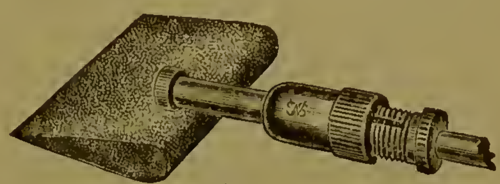


Fig. 702.

points, in shape like the wood polishing-points No. 3, and of closely graded sizes, to be used in the porte-polisher No. 307. A thin strip of bone or ebony or vulcanite should also be at hand having a series of holes that may be made with the barrel burs, each of which will make three different sizes, and the strip serves as a very useful gauge. Selecting then a hard-wood point (one made of copper or of tin-solder would be even better) a very little larger than the cavity, put in it some corundum polishing-paste and carefully grind the cavity larger, circular, and true down to the bottom. Of course, it is next to be thoroughly washed out with alcohol and dried with warm air. With a wheel bur No. 15, or oval No. 91, cut small grooves in the upper and lower walls, but not on the thin side-walls, which would thus be needlessly weakened. Select from the stock of broken or whole porcelain teeth, whether plain-plate, vulcanite, or gum teeth, one which will match the color of the natural tooth, and, with a corundum disc or other wheel, cut out a section somewhat larger than the cavity. But when a stock of cavity-stoppers is accessible, one of these will be preferable because made wholly of enamel, and therefore likely to take a better polish in the process of finishing.

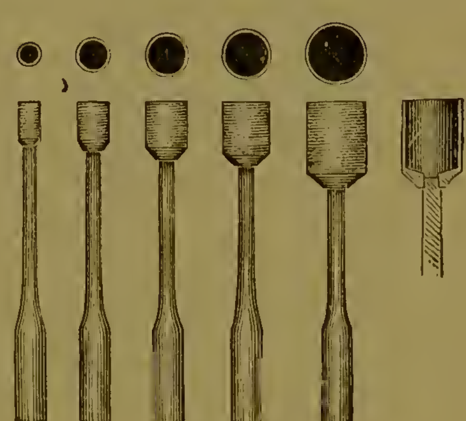


Fig. 703.

Fig. 703 represents a set of diamond trephines for cutting inlays from porcelain teeth. They are made of copper, charged with diamond, exactly like the diamond discs.

"It is worth while to spare no trouble or time or expense in matching as nearly as possible the exact shade of the tooth to be inlaid, because the success of the substitution will greatly depend upon the closeness of its resemblance to the natural tooth. In an emergency choose the lighter rather than the darker shade. When the suitable tooth has been found, and ground to an approximate diameter and thickness, cleanse thoroughly its enamel face with alcohol, and then with shellac melted but not burned, stick the face of the porcelain to the flat-faced end of a wood-point in the porte-polisher. After the porcelain has become quite cool, try it severely to be sure that it has stuck fast, because it will be annoying and cost valuable time if it shall be dislodged and need to be reset when nearly finished. For the purpose of illustration, a cavity-stopper is selected, and is shown mounted with shellac on a wood point. The porte-polisher is put in the engine hand-piece and rotated in contact with a corundum wheel or slab, Fig. 702. For more rapid grinding it may be rotated in contact with a revolving corundum wheel. The gauge previously mentioned will serve for frequent trials in the successive holes until the inlay fits the hole next larger than the cavity. Then the successive trials must be made in the cavity itself until, after grinding on a piece of Arkansas stone, the inlay exactly fits the cavity. In some instances it will be best to wet the inlay with a very fine polishing paste and grind it in the cavity. This is, however, somewhat hazardous, because of the liability of the inlay to get stuck fast in the cavity, and so endanger the cavity-walls. It is then best to grind on the corundum slab the bottom of the inlay, to allow it to settle in the cavity and take up the space previously occupied by the paste between it and the cavity-walls. A fitted inlay will resemble Fig. 704, and for greater security after it shall have been mounted, it will be necessary to cut with a sharp corundum disc notches on opposite sides of the inlay; and to insure the coaptation of these notches with the grooves in the cavity, and at the same time be sure that the inlay shall shade properly with the tooth, it will be best to detach the inlay from the wood before cutting the notches (Fig. 705). Both the cavity and inlay must be perfectly clean and dry before the inlay is lightly placed in the cavity, to determine which is its upper and which its under edge, so that the notches may be correspondingly cut with a clean, sharp, dry disc. Another reason for so cutting the notches is found in the fact that sometimes the lateral curve of the surface of the tooth will be so great that a groove on the lateral wall of the inlay would jeopardize the closeness of the joint on the surface at that point.

"It will, of course, be understood that the process described with reference to the porcelain cavity stopper is applicable to the prepara-

tion of any section from a porcelain tooth, and at this stage of the proceedings it is assumed that the clean, dry, notched porcelain inlay closely fits the clean, dry, grooved cavity. These are to be fastened to each other mainly by a locking-bit of cement or gutta-percha in each of the notches and grooves, in addition to a mere film of such plastic material between the cavity and inlay walls. This is the critical period of the operation, because of the extreme difficulty of so nicely proportioning and evenly distributing the cement or gutta-percha that the joining of inlay and tooth shall be complete in the actual contact of the marginal walls, excepting only the interstitial porosities, which are to be filled with the cement or gutta-percha.

"It is probable that the generality of operators will do best with the phosphate of zinc cement, but in any case, whatever the material of union is to be, the invariable prerequisites are—perfect dryness of both the cavity and the inlay, and some degree of warmth in each of them. These conditions may be best accomplished by a thorough washing of both with absolute alcohol, and the use of the hot-air syringe immediately preceding the mixing of the cement. This should

FIG. 704.

FIG. 705.

FIG. 706.

FIG. 707.

FIG. 708.

be mixed quickly and thin, and a mustard-seed bit of it taken on the blade of a small excavator and placed in the two grooves of the cavity, as also in the two grooves of the inlay; to be instantly followed by the rubbing of the walls of the inlay all over with the least possible cement on the tip of the finger. The inlay is then at once seated in the cavity and with a quick back-and-forth grinding motion pressed firmly into place (taking care that the notches are in right relations to the cavity-grooves), and held under pressure fully five minutes. In cases wherein the inlay has been ground into the cavity, it may be better not to remove the inlay from the mandrel, but to thinly coat its walls with cement, and using the porte-polisher as a handle, turn the inlay into its seat (as a ground stopper into its bottle) with such firmness as to detach the inlay from its shellac attachment to the wood-point, and leave the inlay stuck fast in the tooth. A little white wax is then melted around the joint with a hot burnisher, and the patient dismissed for a subsequent sitting, at least five or six hours later; for it is of great importance that the cement be allowed to get hard before any strain is put upon the inlay. It is also essential to the proper seating of the inlay that no cement be allowed on the floor of the cavity or

the bottom of the inlay, because no amount of pressure will bring the walls into contact if there is a body of cement between those two flat surfaces; and continued pressure for a short time after the seating is necessary lest the elasticity of possibly occluded air lift the inlay from its seat before the cement or gutta percha shall have stiffened sufficiently to hold it in place.

"The rough grinding of the protruding portion of the inlay (Fig. 706) may be done with a stump or crown corundum wheel, until the margins are nearly flush with the tooth-surface, and then a beveled corundum point like No. 7 or No. 12 may be used, as shown in Fig. 707, to make the inlay conform closely to the contour of the tooth, and the final finish will best be given by an engine Arkansas stone beveled like 'R' or 'T,' and used with its further side in contact with the inlay or tooth, or both, as the case may be (Fig. 707). Such use of the side of a grinding or polishing wheel avoids the hollowing or wavy lines which commonly result from the peripheral contact of wheels or points with the convex surfaces of the tooth. Indeed, the preferable polishing instrument would be a device like the old engine

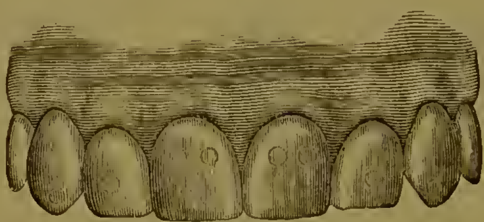


FIG. 709.

FIG. 710.

reciprocating porte-polisher, if it could be given power enough to be effective. A magnifying-glass will aid in making sure that the finish leaves the inlay border quite flush with the enamel at every point.

"Previous to attempting this method of repair, it is advisable that there should be some preliminary practice in setting inlays in teeth which have been extracted, or in pieces of ivory or bone; because there will thus be developed practical points which cannot be here described and yet are essential to the proper performance of the operation.

"The completed inlay, Fig. 708, when suitably adapted and finely finished, may well be considered as exemplifying the nearest approach to perfection in the accomplishment of dental repair that has as yet been achieved."

A method of applying hard or vulcanized rubber to pivot work has been suggested by Dr. J. Richardson, and is briefly described by Dr. J. E. Dexter, as follows: "An ordinary pivot crown is loosely fitted up with a wood peg, which also fits loosely the canal in the root. The

crown is ground from before backward so as to leave a space between the posterior portions of root and crown. Wax applied to the root and crown at once holds the crown and pivot in proper relative position and gives an impression of the root end. The whole is withdrawn, and so invested in plaster that the crown, peg, and wax may be removed, and the crown be capable of accurate replacement on the model. The hole in the root and root model are now properly drilled by the same drill to receive a gold wire pivot. the latter being long enough to project above the root into the crown, and being smaller than the holes in both root and crown, to allow of vulcanite enwrapping it within these spaces. Now the hole in the root model is packed with vulcanite gum, the gold pivot heated and pushed through the gum to its place, the hole in the crown also packed, and the crown forced to its position on the model over the projecting end of the gold pivot. More gum is packed in the palatal groove between root and crown, the whole flasked and vulcanized, and the finished crown forced to its place on the root, a few folds of gold foil being interposed to fill the joint tightly.

"Dr. Richardson also made vulcanite tubes for pivot sockets, to replace those of gold commonly used, by vulcanizing a layer of gum around a gold wire, which should afterward form the pivot. The wire, being wrapped in a single layer of tin foil, was readily drawn from the tube after vulcanizing, the tin being removed with muriatic acid. A proper length of the vulcanite tube was inserted in the root, either by force and a tight fit or by aid of plastic cements, and the pivot, vulcanized to a porcelain crown, was made to take up the extra space in the tube caused by the removal of the tin foil by bending, or by splitting and springing it open."

Also, Dr. H. C. Register's variation of this method, which "is to use an ordinary plain rubber tooth, and form its palatal contour with vulcanite. Through this a hole is drilled in line with that in the root, the latter being filled with hickory wood. The crown now being held in position, a drill is passed through the hole in the vulcanite into the wood in the root, and a gold screw pivot is passed through the crown into the wood root socket, holding the two firmly together. The details need no further description."

A method of pivoting a bicuspid is suggested by Dr. Bishop and described as follows by Dr. Dexter: "The root being a first bicuspid, both canals were opened, and a thin wire set loosely in each, the projecting ends being bent together like a staple over the root face. Gutta-percha was then packed upon the root face, around and under the wire staple. A plain rubber tooth was now ground to fit, and held in place while the gutta-percha was continued over its pins and shaped to contour.

"The whole was now removed together, invested, vulcanite gum substituted for the gutta-percha, and vulcanized. The tooth was set in place with plastics in the canals around the pins.

"This method appears to have much value for certain cases. Variations of it may be noted; for instance, using oxyphosphate, oxychlorid, or fossiline, in place of the gutta-percha, and leaving the tooth in place, for a temporary purpose, instead of removing and vulcanizing. Also, using heavier wires of platinum and iridium alloy for the pivots, and springing them apart, after vulcanizing, so as to obtain their spring pressure in maintaining the tooth in place."

Banded or Collar Crown.—Gold Collar Crowns consist of porcelain crowns with gold collars or bands hermetically inclosing the base of the crown and the neck and exposed portion of the natural root, in order to secure stability, and to prevent decay, and thus permanently preserve the natural root. Dr. W. H. Dwinelle, in the *American Journal of Dental Science*, April, 1855, was the first to suggest the banded or collar crown in connection with crystal gold, for restoring lost or fractured crowns. Fig. 711 represents the shape or mold into which crystal gold was packed, a plate tooth being first backed with gold, to which was soldered a band. The tooth was fastened to the root by a screw passing through a horizontal plate at the base of the backing into the dentine, and a somewhat larger screw was placed and secured in the pulp canal, with the free end projecting into the cap on the crown, and gold was built around this end and the cap filled.

FIG. 711.

What may be more properly termed a "cap crown," or collar crown, was suggested by Dr. Wm. N. Morrison, in the *Missouri Dental Journal*, May, 1869. No screws or pivots were used in his method, but a cap of gold was made in the form of a tooth crown by being swaged on a model or die of a natural tooth, its sides encircling the root, and extending under the gum to the edge of the alveolar process. A bar was soldered across the inside of the cap to afford a support for the oxychlorid of zinc (the oxyphosphate will answer also). The root was then prepared for the reception of the cap, which was filled with the zinc preparation and pressed into place on the root. Dr. B. Beers, in 1873, suggested a method of forming a gold crown from a flat strip of gold by stamping it in the center on a block of lead with a punch. The gold was then annealed, and the two ends bent around the tooth (the stamped surface representing the labial surface of a front tooth), and these ends soldered together. The "bite" was then adjusted by means of a half-round file, so that the tooth articulated properly with its antagonists. A thick flat piece of gold was then bent to suit the form of tooth required and soldered

on the top of the gold crown, which was fastened to the root by inserting headed gold screws into the canal and then filling the cap with oxychlorid of zinc, when it was forced over the root to its proper place. Fig. 712 represents Dr. Beers' crowns and method of attachment to the roots of teeth.

Dr. E. S. Talbot improved upon the method of Dr. Beers by a band fitted to the root and extending to the alveolus, across the inside of

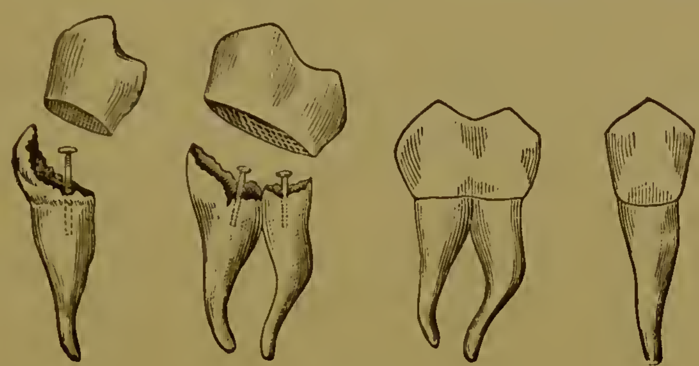


FIG. 712.

which a partition or floor of gold is soldered. In this floor holes are made opposite the pulp canals underneath. Wires are loosely inserted in these canals, and the space in the band beneath the floor is filled with gutta-percha or one of the zinc preparations, and the band or collars forced into position on the root, the wires projecting through the holes in the floor. After the gutta-percha or cement has become hard, the wires are drawn out, and headed screws are substituted,

FIG. 713.

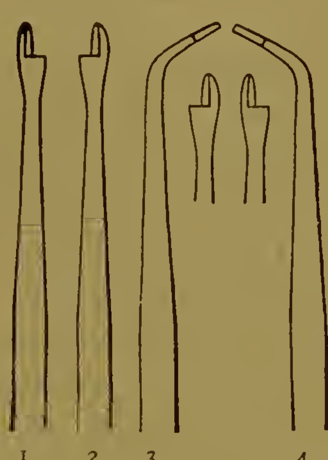


FIG. 714.

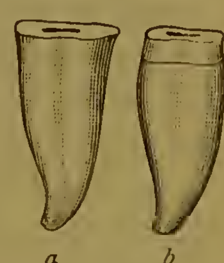


FIG. 715.

which fasten the band or crown to the root. The work is completed by filling the band with gold or by swaging a gold crown or cap, which is slipped over or within the edge of the band encircling the root, the cap being previously filled with cement.

Fig. 713 represents Dr. Talbot's method.

The collar of such crowns, as now made, consists of 22 to 23 carat

gold plate, or pure gold lined with platinum, or iridio-platinum alloy. The coronal portion of the natural root is prepared by first grinding the occluding surface with a properly adapted stump corundum or carborundum wheel (Fig. 716), and finishing with the corundum points. The approximal surfaces are removed by means of cutting discs and thin safe-sided separating files (Fig. 335, page 428), and the corners rounded. The exposed or cervical portion of the natural root is trimmed until it is brought to the shape represented by Fig. 715 *b*, in which the sides are parallel with the line of the root, and the cut surface extends as deep as the collar is to be placed. Fig. 714 illustrates the root-trimmers for shaping the cervical portion of the root. Where a large portion of the crown of the tooth is to be removed in preparing the root, a succession of holes may be drilled across such a portion, and the partitions removed by a fissure-bar or corundum disc. As much of the natural crowns of bicuspids and molars as possible should be preserved for the stability of the artificial crown when such is of all gold or a porcelain

FIG. 716.

facing is employed in connection with gold to form the crown. The preparation of the root canals is the same as before described. The root trimmers or reducers devised by Dr. R. W. Starr are intended for trimming the edges or reducing the diameters of roots over which collars are to be placed. The shoulder keeps the instrument on the root and limits the penetration of the spur, which, by its knife edge, scrapes the side of the root (Fig. 715 *a*), so that it may easily and quickly be given the shape of Fig. 715 *b*, or any similar form. They are made right and left (Fig. 714); the straight pair (Nos. 1 and 2) for use on the superior roots anterior to the molars, and the curved pair (Nos. 3 and 4) for use in all the other natural roots.

Dr. C. M. Richmond's method of making what are known as the "Richmond Crowns" is as follows: This crown consists of a close-fitting band or ferrule of coin-gold plate, to which a cap or surface, corresponding to the grinding surface of the class of tooth it is designed to crown, is soldered. The root is prepared by making the exposed surface flat by means of the file or corundum disc. A strip

of gold plate, about No. 27 American gauge, is then cut, of such a width as will extend from the alveolar process to a height sufficient to give the proper length of gold crown. To determine the proper width of the strip or ferrule, a pattern of tin or sheet lead, adapted to the tooth, may be used. The strip of gold plate is then bent with the pliers and filed to the proper form, and the overlapping ends soldered together, the ferrule being made slightly smaller than the root it is to encircle, so as to secure a tight fit. After the band or ferrule is completed, it is capped by a piece of plate large enough to cover the crown end, and the two soldered together, and properly finished by smoothing the sharp edges with a file and burnisher. The cap or crown is then adapted to the festooned margin of the gum and septa by filing the approximal edges concave. The margin of the gold crown, where it comes in contact with the neck of the root, is slightly beveled from the outside, in order to make a thin edge which will adapt itself to the surface of the neck under the pressure necessary to force the crown to its place on the root. The crown is then forced over the root, and the position of the artificial cusps yet to be made determined by the antagonism of the opposing teeth. Small, flattened buttons, made by melting scraps of plate and slightly flattening them by blows with a hammer, are soldered on the grinding surface of the gold crown, which is filled and invested during the soldering process with moistened sand, to which is added a little plaster. After thus attaching the cusps and contouring the grinding surface, the gold crown is ready to be adjusted to the root. A small hole is first drilled through the side or top of the crown, to allow the surplus cement, by which the crown is secured, to escape. The concavity of the crown is then filled with either the oxychlorid or oxyphosphate of zinc, mixed somewhat thinner than for a temporary filling, and the crown forced over the root and the patient directed to bite upon it, in order to secure the proper occlusion of the teeth. The crown is then firmly held in place until the cement has hardened, when the small hole through which the surplus has escaped can be filled with gold. Any slight defect in the articulation can be remedied by grinding with corundum points.

The method of Dr. H. W. F. Buttner is a combination of the ferrule, or band encircling the root, and a central pivot, and is described as follows by Dr. J. E. Dexter:—

"A special set of instruments is used in this process. Those for preparing the root are drills, reamers, and trephines (Fig. 717, *b c d*). The drill bores out the root canal. The reamer cuts the face of the root level, being guided by a central pin. The trephine turns the neck truly cylindrical for a certain distance up or down its sides, being also guided by a center pin. The root, thus prepared, is shown

in Fig. 718. The drill, reamer, and trephine are in various and exactly corresponding sizes.

"A steel wire is now placed in the root, projecting half an inch. An impression is now taken, the wire projecting through it, a cup with an opening over the root being used for that purpose. The wire is withdrawn carefully before removal of the impression from the mouth, but is afterward replaced. Over it, on the impression, is now slipped that one of a set of brass root models which corresponds to a drill and trephine used, and the model is then made, and holds the brass root model in its place, with the wire projecting. The latter is now removed, and plaster cut from around the root model to a depth sufficient to accommodate the cap which is to follow. This is of gold, struck out of the solid, on that one of the accompanying steel dies which accords with the trephine and root model used. It also has a central pin, to correspond with the drill which enlarged the root canal (Fig. 718). This cap is set on the root model, and a plain plate tooth, ground hollow on the inner surface, to cover the outer wall of the gold cap, is backed, and soldered in place on the cap—of course, after removal from the brass root model—the solder forming the palatal contour. The whole is now polished, placed on the root, and driven home with a mallet (Fig. 719).

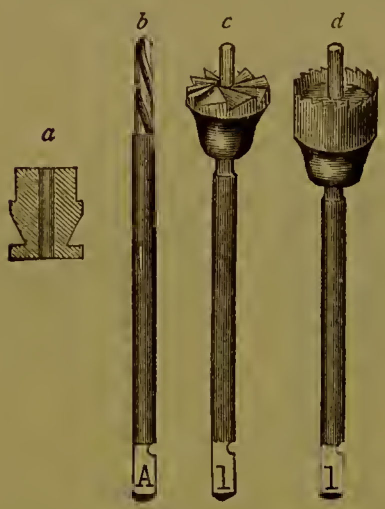


FIG. 717.


FIG. 718.

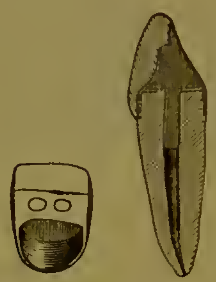


FIG. 719.

"The perfectly accurate fitting of this operation is secured, beyond cavil, by the set of drills, reamers, trephines, dies, and root models with which it is performed. Probably—indeed, almost certainly—this is the *strongest* method of attachment of artificial crowns to natural roots which can be devised. Indeed, the only thing breakable about any given case of this method seems to be the porcelain crown or face. The end and interior of the root, also, are absolutely preserved from moisture for, at least, a very long time."

Another method of forming collar-crowns is described as follows by

Dr. C. S. W. Baldwin : * "Select a Logan crown slightly shorter than would be used for setting without a ferrule. Countersink and prepare the inside of a root as for a Bonwill or any ordinary crown. If the outside of the root at the margin of the gum presents an irregular surface, then with Dr. Starr's reducers (Fig. 714) shape it to such a size that the ferrule may be perfectly adapted to all parts. Take an impression, and produce in zinc or Babbitt's metal a die, to form which take a plaster model of the root-end, an eighth of an inch long, and shellac it to the point of a cone, which can be easily made by turning down a large spool, thus making the deep mold in sand into which the metal is poured. With this die strike the gold (22-carat, No. 30 gauge, is most commonly in use), laid upon soft lead. A few blows will produce a seamless and perfectly-fitting cover and ferrule. After trimming this to fit the festoon of the gum, drill in it from the lower side a hole for the pin of the crown, leaving the ragged edge produced by the drill. Then fill the countersunk portion in the porcelain crown with oxyphosphate of zinc, and with the gold ferrule or cap in place, adjust the crown as you would wish it when completed. When the oxyphosphate is hard, you will find the ragged edge on the upper side of the cover will materially aid in removing and keeping the cap where it belongs. Unite the cover to the platinum pin in the crown with a small amount of soft solder—tin and lead—using muriate of zinc as a flux, a few blasts from the blowpipe being all the heat required. Then fill the root with oxyphosphate and firmly press to place. These caps might be made up at leisure, providing a few variations for double and single rooted teeth. When a case is met that you cannot fit from your stock, choose a cap larger than the end of the root, and with a single clip of the shears cut to the center of the cap, and with pliers spring together, lapping the edges until the size required is obtained. Solder with gold solder by holding over the spirit-lamp, and proceed as before.

FIG. 720.

FIG. 721.

FIG. 722.

"Fig. 722 shows a root, cover, and Logan crown ready to be assembled for the soldering of the crown-pin to the cover; Fig. 720 shows the cap cemented and soldered to the crown, and Fig. 721 the completely crowned root."

* *Dental Cosmos*, vol. xxviii.

Dr. H. C. Merriam describes a form of artificial crowns as follows:*—

"We need a crown that can be ground on its sides as well as against the root, with a straight hole through it, similar to that of the English tube teeth, excepting that the hole should come out at a greater distance from the cutting edge in the incisors and cuspids. After the crown is ground, to place the hole through, it may be formed as we desire with a copper drill and corundum, or with hard-rubber points dipped in corundum.

"There are now made, for use in machine-shops, wheels the corundum of which is united with a flux, and baked at a temperature of nearly three thousand degrees. These wheels hold a true edge, and when made small enough will be a great step in advance of what we have. I have had small points made in this way, with which I can grind out a crown to any of the forms illustrated in Fig. 723."

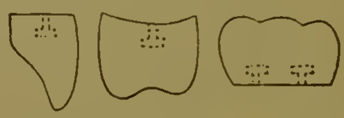


FIG. 724.

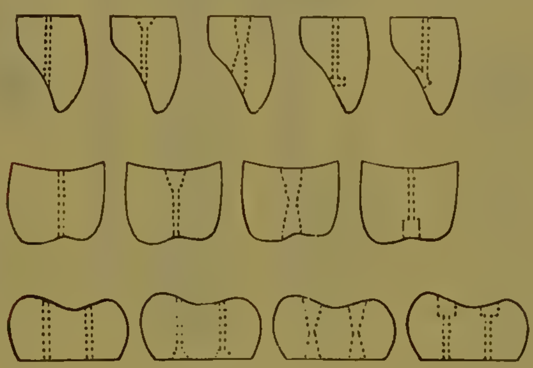


FIG. 723.

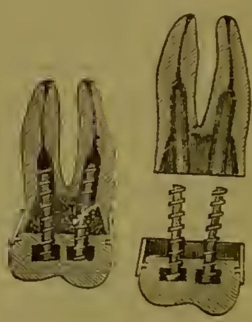


FIG. 725.

"I now show you some of the different varieties that can be made by grinding the crown just referred to (Fig. 724), the advantages of which have already been stated. With these crowns it is expected that dowels will be used, set in either cement or gutta-percha.

"We will now pass to forms which are to be secured by metal bands fitted either to the root or to the crown itself (the strongest, of course, being held at their periphery), and I will detail my method of applying the same, for it enables me to avoid the trouble and delay of investing or soldering. For these the crowns given in Fig. 723 may be used, as well as those shown in Fig. 724.

"The band is fitted to the root, and the crown ground into the band after proper occlusion with its antagonist has been obtained. If a

* *Dental Cosmos*, January, 1887.

molar, a fine groove is ground around it, and the band, after being corrugated on its inner surface with a small lining bur, is placed on a lead anvil and the tooth driven into it, thus partially securing the advantage of union by gomphosis. The common glass stopper is a good illustration of how little more than its fit would be required to retain it firmly in place. For this little I have drawn on the tube-teeth workers of England. A few small pieces of sulphur are then placed inside the band, and all held over a small flame until the sulphur melts and flows into the groove between the band and the crown. Zinc phosphate may be used before the crown is forced in, or some flux—borax, for instance, which melts at a low temperature, though this would probably require investing. We then have a crown which, if a molar, I do not fear to attach with gutta-percha without dowels; but others may not have this confidence, and dowels may either be put into the roots or set in the crown with cement, and afterward secured to their places in the root as usual (Fig. 725). It is evident that if

FIG. 726.

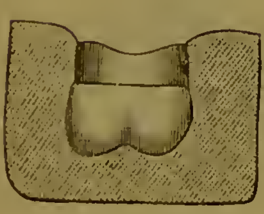


FIG. 727.

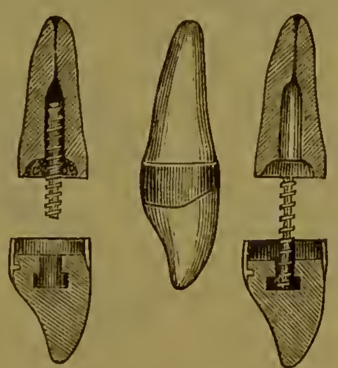


FIG. 728.

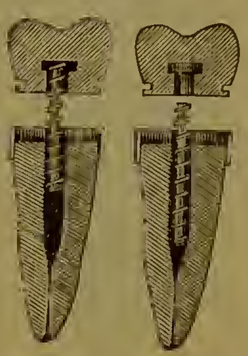


FIG. 729.

cement is strong enough to hold a dowel in the root it must be equally serviceable in securing the crown to the dowel. Some like the hardest way best. These may fit a fine platinum or pure gold wire into the groove around the crown (Fig. 726). Drive in as before; invest and solder (Fig. 727). A gold amalgam may be used, such as was employed by old plate-workers for banding a plate over the teeth. I have not tried this, but suggest it as of possible use, the dowels being put in as before. For the incisors the groove should not run around the anterior face of the crown, and I have not soldered these teeth in (Fig. 728). I have entire confidence in any form for the incisors and bicuspids where the root is well banded, the dowel put into the center, and the crown forced to place in gutta-percha (Fig. 729); while for the molars, if quite short, I do not care for the dowels. You will notice that this method does away with much of the showing of gold in molars, where such a result is desired (Fig. 730).

"When cohesive gold was first used we thought nothing could be more beautiful—the more conspicuous the better—but we gradually learned that the perfection of art was to conceal art. So it is with tooth-crowns, and we shall learn soon to omit great backings, etc., wherever possible; not only because they are conspicuous, but because a tooth backed up by any substance is no longer translucent.

"I will present one more form for molars, and although it shows more gold than any of the others, it is perhaps the strongest of all. The band is made full width down to occlusion, and any large, strong tooth is ground to fit the space to be filled in the arch. This is driven into the band so as to be even with its edge; cemented with

FIG. 730.

FIG. 731.

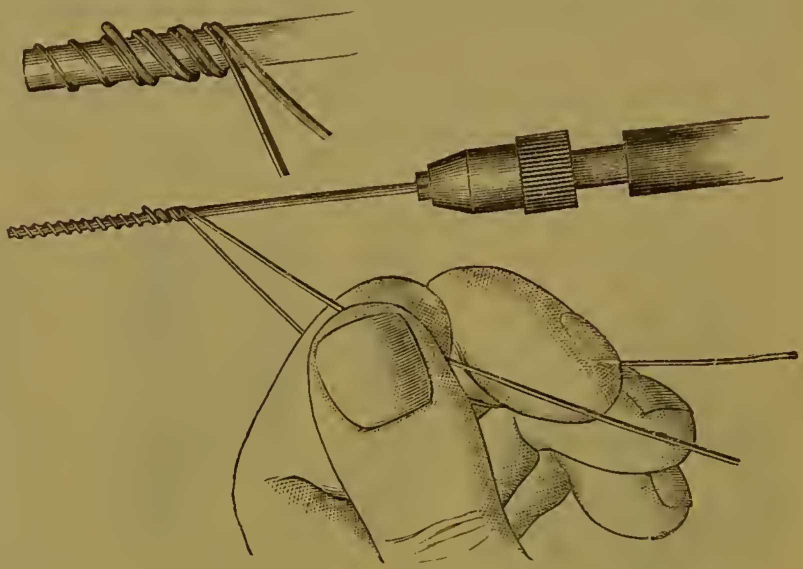


FIG. 732.

sulphur as before, and I think we have a crown that is made for all time (Fig. 731).

"*Setting.*—I first varnish the band inside with Canada balsam dissolved in ether; then fill the crown with gutta-percha and crowd it up against the root several times, to get an impression. When sure that I have the right amount of gutta-percha, I place the dowels in the root (if I am to use them); heat the crown; dip it into cajeput or any essential oil, and crowd it to place. The dowels I fit in the same way, wrapping them with gutta-percha and working up and down in the root until I get the impression, before the final forcing to place. I thus have the advantage of the dowel and hard center of gutta-percha to act as a plunger, and the soft, semi-dissolved gutta-percha comes back on the outside of the mass, forming, I think, the tightest root-filling known. I fill roots in this way with gutta-percha points when I do not use a dowel. The dowels used are made by wrapping a piece

of platinum and iridium wire with about one-third of a sheet of gold foil, which is melted on and the combination made true by being drawn once through a wire gauge. A piece of piano wire is then wound around it three or four times, to serve as a guide, and a fine platinum wire, previously drawn square, is caught and turned through the wire guide a few times, when the winding may either be finished by hand, or the end, after being started, may be placed in a lathe-chuck and wound up at once (Fig. 732). A piece of gold foil is then wrapped around the whole and the fine wire soldered on. A dowel made in this manner is not strained by having its thread cut, and the thread, being square and coarse or fine, as you wish, is strong and possesses plenty of grip.

"Should these forms prove as valuable as I hope, those at a distance from the cities, without gas, will find that the labor of crowning roots has been much lessened.

"When a root has broken off far under the gum it should be filled with gutta-percha and a temporary plate worn—if the loss be in the front of the mouth—until the root works down, when it may be crowned and the plate given up.

"In preparing roots after a large portion of the crown is broken away, I enlarge the pulp-chamber with a large, round bur, and, when even with the gum, follow with the revolving saw here shown (Fig. 733). With this saw I often cut off the remnants of a crown from the inside without wounding the gum or drawing a drop of blood, and am saved the unpleasantness of running a stump corundum wheel in the mouth. The outside of the root can sometimes be formed with the instrument here shown (Fig. 734)."

FIG. 733.

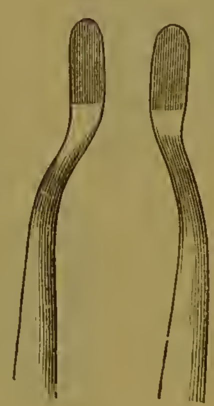


FIG. 734.

Fig. 735 represents porcelain cusp-crowns. These porcelain cusps are designed for use with a gold band representing the body of the tooth. The band or collar is first fitted to the suitably prepared root, and the cusp-crown is then fitted in the collar. The collar is then filled with gutta-percha, cement, or amalgam, and the crown pressed into place. 1 shows in section a molar root, collar, and cusp-crown. 2 shows the same mounted.

In cases where it is desirable to show as little of the gold collar as possible, the forms indicated in 3 and 4 may be employed, the gold band being cut away on the buccal side, as shown in the cuts.

Dr. E. T. Starr, in the *Dental Cosmos*, describes an improved "die-

plate" and "hubs" for shaping metal cap-crowns, of his own suggestion :—

"In the construction of metal cap-crowns to cover natural teeth or teeth-roots there are many methods which result in good work, but in most cases the caps do not articulate as well as they might, for the reason that means for embossing the bicuspid and molar cusps are not at hand or available within the short time at the disposal of either the patient or the dentist. With the object of providing an easy and quick way of working under such circumstances, I have made a single

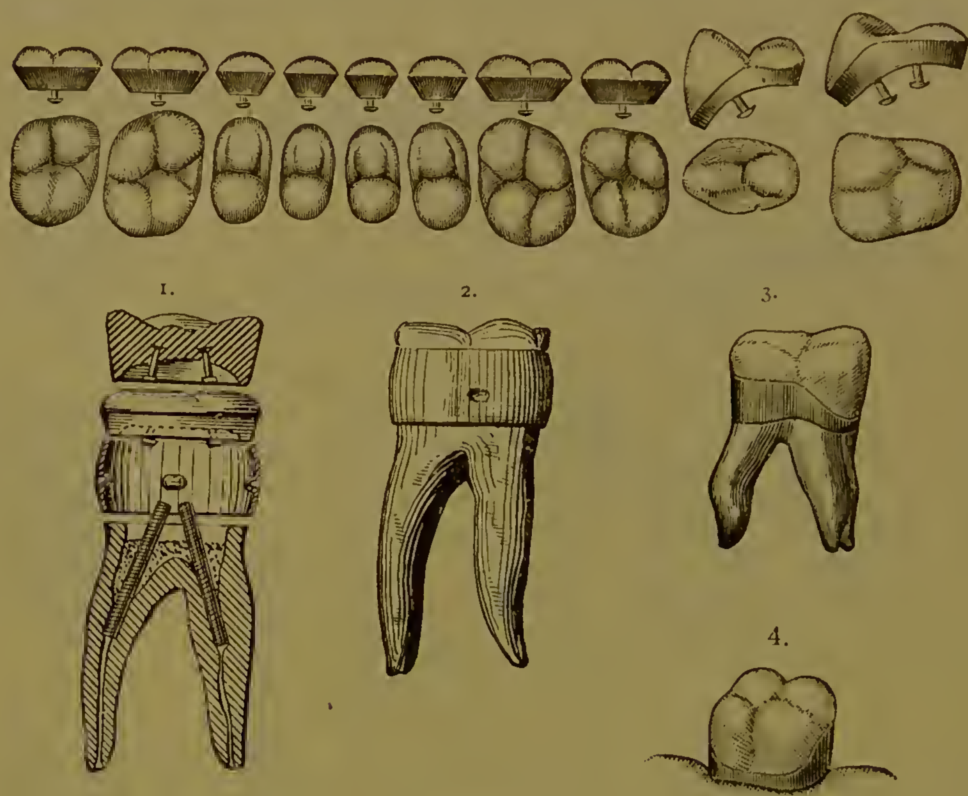


Fig. 735.

plate (Fig. 736) in which are four groups of intaglio dies representing with distinctive correctness the peculiar cusps of the upper and lower right and left bicuspids and molars. These are indicated by the Hillischer notation, so that each form may be easily identified in practice.

"The hubs A, B (Fig. 737) are of the sizes shown, and are made of an alloy composed of tin one part, lead four parts, melted together. The mold C should be warmed, the melted alloy poured in every hole, and the overflow wiped off just before the metal stiffens. This will make the butts of the hubs smooth and flat. After a minute or two the mold may be reversed, the hubs shaken out, and the casting process continued until a considerable number of hubs shall have been cast.

"In Fig. 738 a molar hub is shown in place on a piece of No. 32 gold plate, which lies over the 6. (upper right first molar) die. A

FIG. 736.

succession of blows on the hub, with a four-pound smooth-faced hammer, will drive the plate into the die, and at the same time spread the

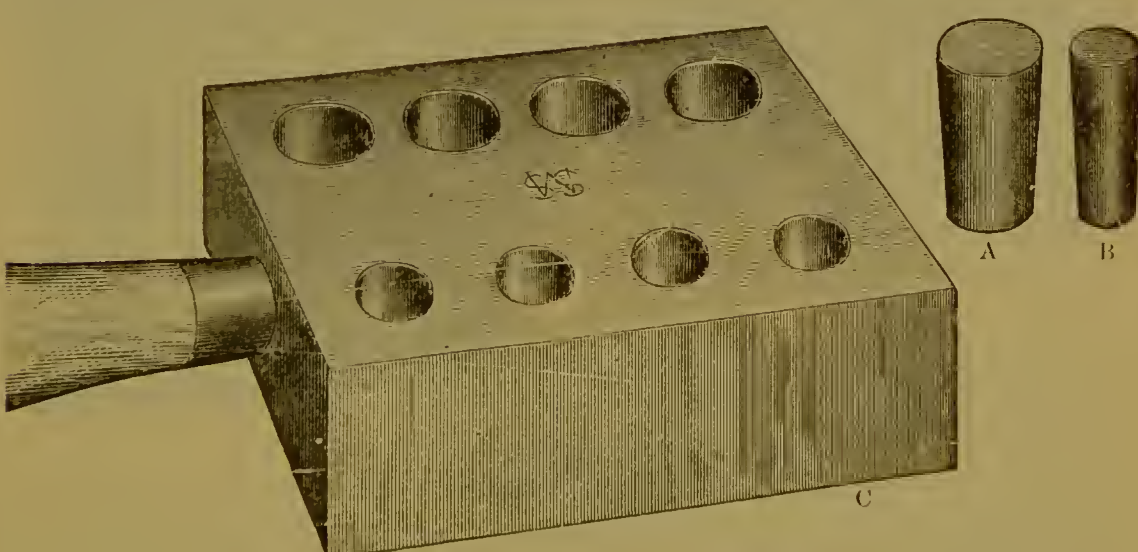


FIG. 737.

hub metal from the die center to its circumference in such a manner that the plate will be perfectly struck-up with the least possible risk of being cracked. The flattened hub is seen in Fig. 739, which also

shows at D the obverse of the struck-up hub, and at E the cameo of the struck-up plate, having every cusp and depression of 6. sharply defined.

"The counter-die plate (Fig. 736) is made of a very hard cast metal, which will admit of the striking up of many crown-plates by the means and methods described, if the crown-plates be not too thick and stiff. Of course they should be annealed before they are placed over the die. In careful hands, the die-plate should give clear cusp definitions after years of use.

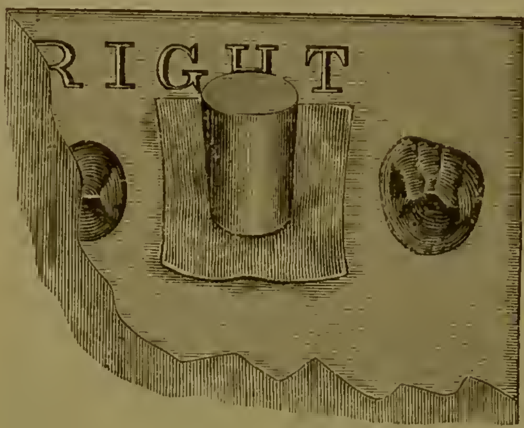


FIG. 738.

"For the reason that the counter-die plate is in some respects similar to a stereotype plate for printing, the struck impressions on two strips of thin plate will appear as in Fig. 740, wherein their regular order is noticeable as seen from the cameo surface of the struck plates. The peculiar action of the hub in forming first the center of the crown plate, and spreading from the center outward, as the hub is shortened under the hammer, until the die is overspread by the plate and hub, with the result shown in Fig. 739, is an essential feature of

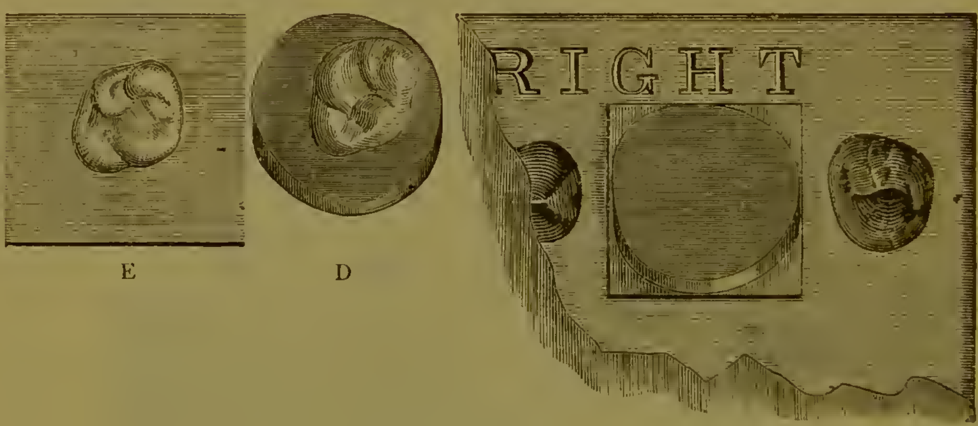


FIG. 739.

this process for obtaining easily and quickly the superior styles of coronal cameos shown. If a cusp or fissure should chance to crack in hubbing, a small piece of plate may be struck over it, or another crown plate be struck over the first and the two soldered together.

"The depressions in the struck plate can be partly or wholly filled

with scraps of plate or solder, and the surplus plate cut away from the cameo.

"The fact is noteworthy that, by means of the Knapp blowpipe, the coronal intaglio may even be filled with melted scraps cut from the identical plate out of which the cameo was struck. The better way, however, is to fill, say a twenty-carat cameo with eighteen-carat plate scraps. The fitting and soldering of the doubled or filled cameos to suitable collars is a simple matter, and need not be described.

"It only remains to add the statement that, by this counter die and hub process, gold, platinum, silver, or other metallic cap-crowns, having finely-formed and solid cusps for proper occlusion and re-

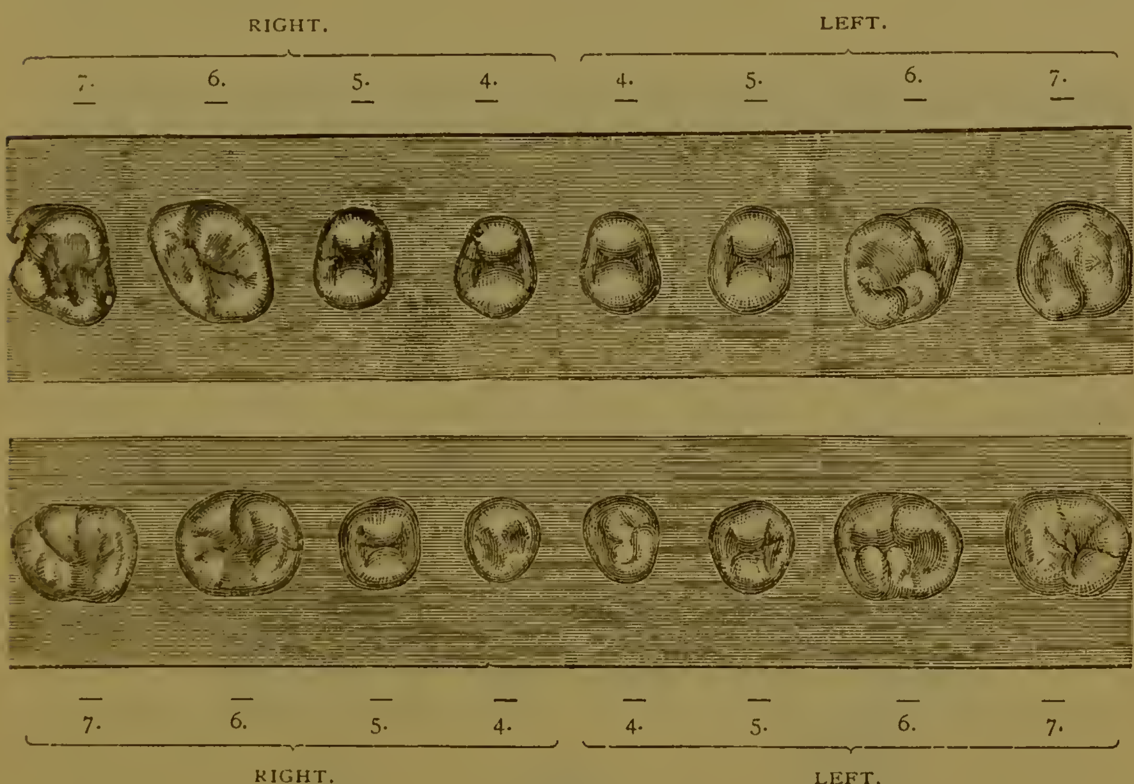


FIG. 740.

sistance to wear, can be made with little trouble and in a very short time."

All-Metal Crowns.—Entire crowns of either gold or aluminum are employed for capping badly decayed or fractured posterior teeth. These crowns may be made either in sections, composed of a collar or ferrule and grinding surface, or as seamless contour crowns by a stamping process. In constructing a crown in sections the collar of 23-carat gold may be first formed on a mandrel, and then placed in a die obtained from a model of a natural crown, and burnished to the sides, or stamped between a die and counter-die representing the crown of a natural tooth. After the collar, which may be seamless, or its ends soldered together, is contoured, the cap or grinding surface, of a size

suitable to adjust to the collar, is stamped with a die (Fig. 741) and adjusted and soldered to the collar. Having the collar part of the crown a little smaller or contracted than the cervical part of the prepared root which it is to cover, will permit of a nice adjustment, as the gold, especially in the case of a seamless crown, will expand when forced or slipped over the end of the natural root, and can be trimmed with curved scissors or shears, and closely adapted to the root and gum. Stamped seamless aluminum crowns are made in the same manner as the gold seamless crown, the construction of which is described by Dr. George Evans in his work as follows: "A contour crown can be made by placing a seamless cap on a sectional die or mandrel of the shape of the tooth, first swaging the grinding surface on the mandrel and then stamping downward on the straight sides of the crown with a cap fitted to the shank part of the mandrel." A sectional mold method is, however, more simple and practical, and is described by the same author for a molar crown, as follows: "A natural tooth, or one made of plaster, is used as a model. From this a sectional mold is made in Babbitt's metal, zinc, or fusible alloy. Into the mold a cap of gold 23 to 24 carats fine, 30 to 32 gauge, is adjusted, fitting tightly the orifice of the closed mold. The mold is placed in a vise, the cap expanded to the general form of the mold by hammering into it a mass of cotton, and then swaged more in detail to the form, and with a wood point or burnisher revolved by the dental engine burnished into every part of the mold. To facilitate the process, the mold should be frequently opened and the gold annealed." "Another method is to form a fusible-metal die of the tooth to be crowned, and, after having stamped the grinding surface of the crown, to reverse and swage the sides close to the die; the crown is then relieved of the core (die) by heating to the melting point of the fusible metal and pouring it out."


Fig. 741.

Figs. 742 and 743 represent solid gold cusps for crown and bridge-work.

Gold cap-crowns can be rendered more durable by filling in the under surface of occluding portion of the crown with gold solder.

Fig. 744 represents the Evans Gold Seamless Contour crowns for bicuspids and molars.

The Hollingsworth system for crown and bridge-work is described by its author as follows:—

"This system supplies, in the first place, a variety of forms for the various teeth, great enough to cover almost any case, and for the rare cases which cannot be suited direct it affords a ready means of making the exact form required. There are in the set 204 forms of

cusps and 36 of facings for bicuspids and molars, and 40 forms for incisors and cuspids. These last give both the labial and lingual faces. All the forms are exact fac-similes from nature, selected with

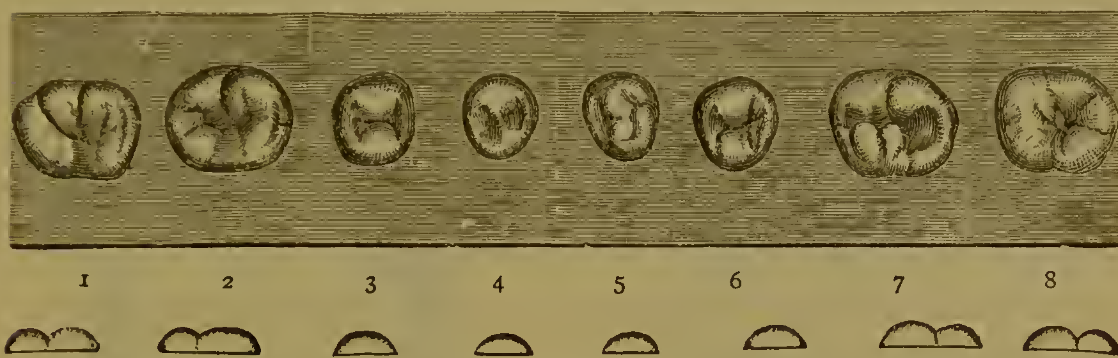


FIG. 742.

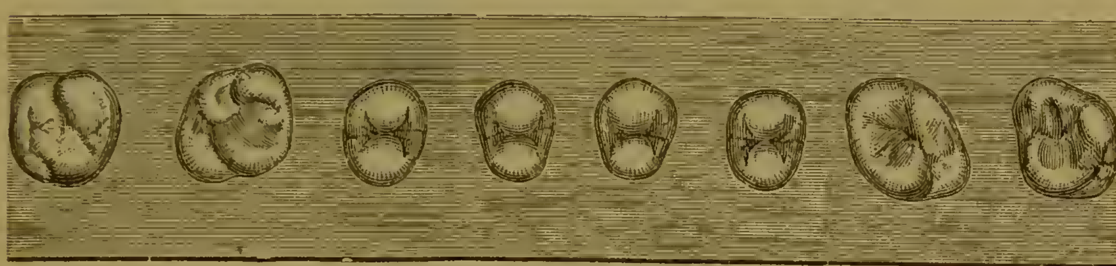


FIG. 743.

great care to cover the widest range possible. They are made of metal, and are used as patterns from which to make dies or molds, as may be required, for the swaging of gold cusps, or crowns. There is

FIG. 744.

therefore, no wear upon them, and they retain their shapes and sizes unaltered.

"The outfit for working these forms consists of a molding-plate, three rubber rings, a sheet of asbestos 10 × 7 inches, a carbon stick for use

in casting, and a box of Hollingsworth's annealed copper strips for measuring roots.

"This system permits cusps to be made either hollow or solid. Scrap gold can be used for casting solid cusps, and porcelain facings can be quickly inserted in crowns without investing; but perhaps its most

FIG. 745.

FIG. 746.

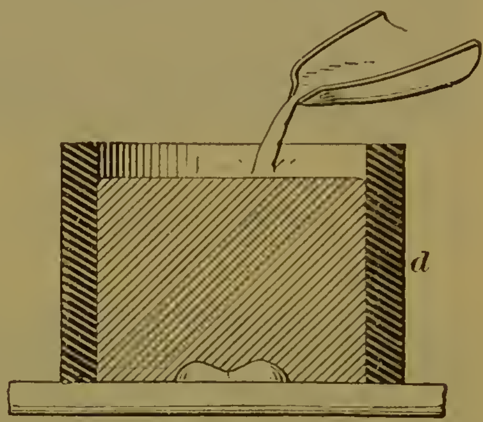


FIG. 747.

important advantage is the exactness with which the fit and articulation of bridges are obtained and maintained."

To Make a Gold Crown (*Bicuspid or Molar*).—Make a band to fit the root in the ordinary way. Place the band in the mouth (see Fig.

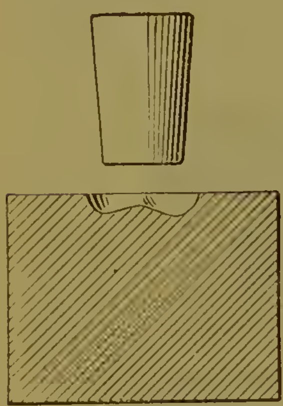


FIG. 748.

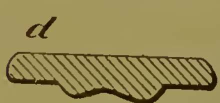


FIG. 749.

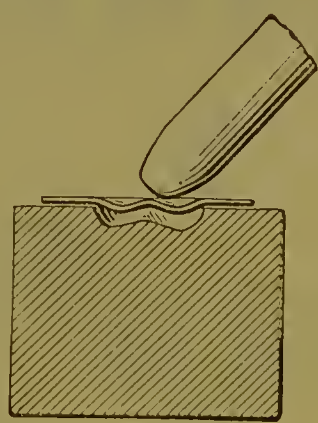


FIG. 750.

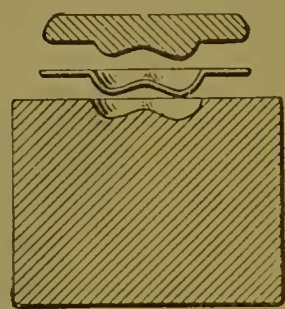


FIG. 751.

FIG. 752.

745), and cut off on a line where the adjoining teeth begin to turn to form the cusp (see *c*, Fig. 745). Place a small piece of wax inside the band to assist in holding the cusp-button, which should be selected to fit the circumference of the band, to articulate properly, and to correspond in shape with the other teeth (see *b*, Fig. 745). Remove the

button, and place it on the molding-plate with the grinding-surface up (see Fig. 746). Place the small rubber ring *d* around it, pour in a sufficient quantity of Melotte's metal to nearly fill the ring (Fig. 747). As soon as the metal sets, chill the surface by dipping in water for a moment, and then remove the rubber ring. When the heat begins to return to the surface, a quick rap of the die on the bench will cause the cusp-button to drop out and leave the mold ready to form the gold cusp. Now take a piece of lead, such as our lead hubs, and with a hammer drive into the Melotte-metal die (Fig. 748) to form the counter-die (Fig. 749, *d*).

Anneal the gold plate, and start the swaging process by coaxing the plate into the die by hand-pressure (Fig. 750), using a piece of wood, which makes a depression for the lead counter-die to rest in. Then place the counter-die on the gold plate (Fig. 751), and drive to a fit. Cut the surplus metal from the hollow cusp with shears (Fig. 752), filing up the edges when necessary, and rub down the under surface on a smooth file until it fits the band made for it (Fig. 752). Wire the cusp and crown together, place flux and solder in the cap, and hold over a lamp until soldered (Fig. 753). Then finish in the usual way.

If the forms of cusp-buttons do not afford one which articulates perfectly, the difficulty is easily remedied by taking the button which most nearly answers, and building up the cusps with Melotte's moldine (Fig. 754). If a band is accidentally cut too short, it can still be utilized. Place moldine upon the molding-plate, put the cusp-button upon it, press down and adjust to make up the deficiency of the band, cutting away the surplus moldine.

Fig. 753.

Fig. 754.

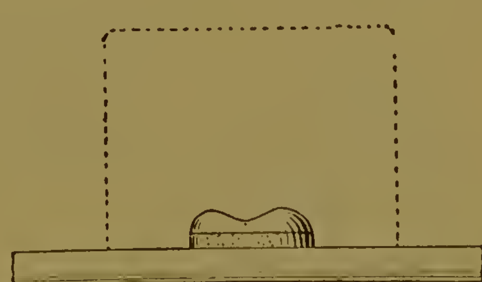


Fig. 755.

This will of course throw the soldering line a little further upon the crown (Fig. 755).

Scrap gold can be utilized for making a solid gold cusp by casting in asbestos by the following method :—

After selecting the desired cusp-button, instead of making a mold in Melotte's metal, as before described, take a piece of asbestos board

about one inch square and one-fourth inch thick, moisten it, and with a hammer drive the cusp-button into it, flush with the surface of the button. (See Fig. 757.) Remove the button, and dry the asbestos in a flame (Fig. 756). When perfectly dry, place a sufficient quantity of gold scraps in the die made in the asbestos, and direct the blow-pipe flame upon it until melted, inclining the carbon stick, as shown, against the die for the double purpose of confining the heat and warming up the carbon stick. When the gold is fused into a button, press it into the die with the carbon stick (Fig. 758). *Avoid the use of flux when working with asbestos.*

FIG. 756.

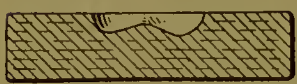


FIG. 757.

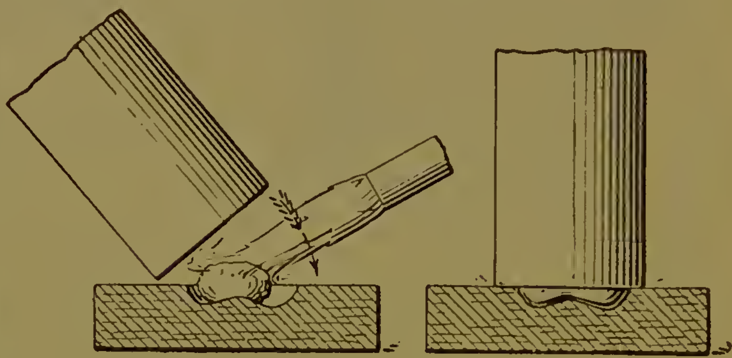


FIG. 758.

To build up a cusp to make a perfect articulation, in this method, sealing-wax must be used instead of moldine, as in the method of swaging the cusp. Warm the button before applying the wax, and with a warm instrument shape the cusp as desired.

To Make Gold Crowns (*Centrals, Laterals, and Cuspids*).—Select from the forty different forms in the set that which is most suitable to

FIG. 759.

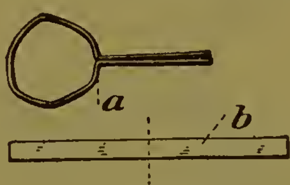


FIG. 760.

FIG. 761.

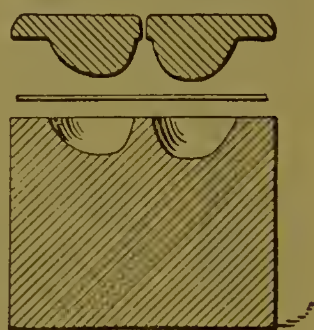


FIG. 762.

the case in hand (Fig. 759). (The forms are in pairs, showing labial and lingual surfaces.) Take the measurement of the root to be crowned with one of the annealed copper strips, binding the strip around the tooth with pliers (Fig. 760 *a*). Take this measurement

and cut it through the center (Fig. 760 *b*), then bend the respective halves over the lingual and labial forms selected, at the necks, with the cut ends of the strips resting on the flat of the plate (Fig. 761). If the measurement is larger than the form selected, build the latter up with moldine until the space between the form and strip is filled (Fig. 761 *b*). Avoid getting moldine on the approximal surface. Remove the strips, dry out the moldine by passing through a flame a few times, then place the form on the molding-plate with a rubber ring around it. Pour Melotte's metal into the ring as in forming the molar or bicuspid cusp, which makes a die of the two sections, lingual and labial. Make a lead counter-die and proceed as directed in the making of a molar cusp, swaging both sections (Fig. 762). Trim off the surplus plate (Fig. 763), and square the opposing edges of the two sections by rubbing them over a dead smooth

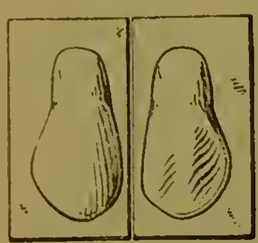


FIG. 763.

FIG. 764.

FIG. 765.

FIG. 766.

file. Bind the two sections together with wire with sufficient solder and flux inside (Fig. 764, and Fig. 765), and proceed as in soldering an ordinary band. With a small mechanical saw cut off the upper portion where the tooth begins to slope back (about the dotted lines in Fig. 765). This leaves the crown as shown in Fig. 766, approximal and labial views. Drive on the root. If too small, place on the horn of an anvil and enlarge by hammering; if too large, band the root in the same manner as for a Richmond crown, grinding the tooth to fit.

To Insert a Porcelain Facing.—Make the gold crown as described. Select a porcelain facing suitable for the case (Fig. 767). Place the crown on the root in the mouth, and with an excavator mark on the face where the porcelain is to appear. Remove the crown and saw out, so that the facing will fit loosely. With a knife bevel the inner edge or seat for the facing (Fig. 768). Grind the facing to fit (Fig. 769). Back up the facing with No. 34 or 36 gauge pure gold, punching holes in the backing for pins, annealing as required to readily conform it to the tooth (Fig. 770 and Fig. 771). With a sharp knife

cut a barb on each side of the pins in the facing, and press the barbs against the backing (Fig. 772), which keeps the backing in place. Burnish down the edges well, being careful not to let the backing overlap the facing.

Place the facing in the space prepared for it in the crown (Fig. 773), and bind the two together (not too tight) with wire, wrapping the wire directly over the facing with asbestos to prevent discoloration of the porcelain. Flux and solder by holding over a lamp as in the case of a band (Fig. 774). Then finish in the usual way.

If it is desired to use a platinum pin for anchorage, as, for instance, a Logan pin, bend the pins in the facing sufficiently to clamp the anchorage pin, and insert the pin through the gold crown (Fig. 775),

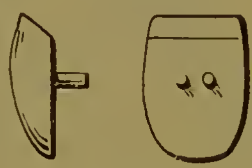


FIG. 767.

FIG. 768.

FIG. 769.

FIG. 770.

FIG. 771.

FIG. 772.

FIG. 773.

FIG. 774.

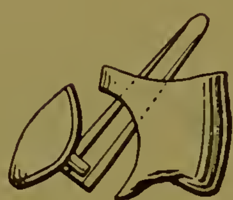


FIG. 775.

FIG. 776.

finishing as before described. Fig. 776 shows a finished crown so made.

To Make the Grinding Surface of a Bridge in One Continuous Piece.—After having crowned the teeth for the attachment of the bridge, take a bite in modeling compound, remove the compound, place the crowns in their impressions, make a cast of sand and plaster, and place on an articulator; now put moldine between the abutments instead of wax, and get the articulation with cusp-buttons the same as you would for plate teeth (Fig. 777). Then to remove the buttons without destroying the articulation, make a cup by pouring Melotte's metal, as cool as it will flow, on the face of the cusp-buttons. Heat the pouring lip of the ladle and use it to smooth out the half-congealed metal,

much as you would a soldering iron (Fig. 778). Then place a thin coating of moldine upon the molding-plate. Remove the cup from the articulator with the cusp-buttons in place (Fig. 778). Transfer the cusps by inverting the molding-plate (Fig. 779), and turn the cusp-buttons out upon the moldine on the plate with the grinding-surface up (Fig. 780), and they will occupy the same relative positions as when on the articulator.

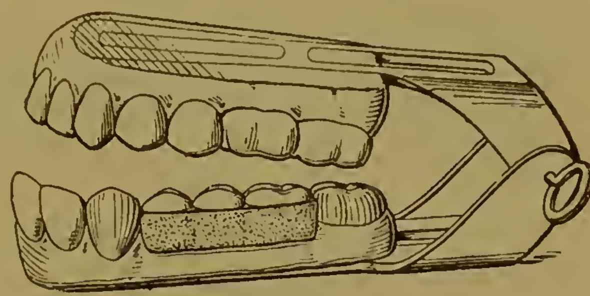


Fig. 777.

Now place the large rubber ring around the buttons on the plate, and proceed to make a die with Melotte's metal, as before described (Fig. 781). When cool, remove the buttons and coat the face of the die with whiting. Invert the die and raise the rubber ring sufficiently

Fig. 778.

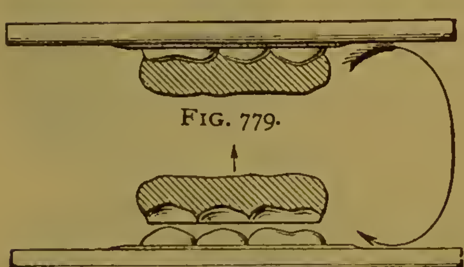


Fig. 779.

Fig. 780.

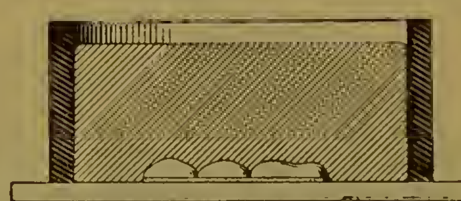


Fig. 781.

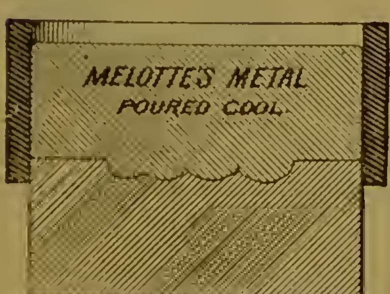


Fig. 782.

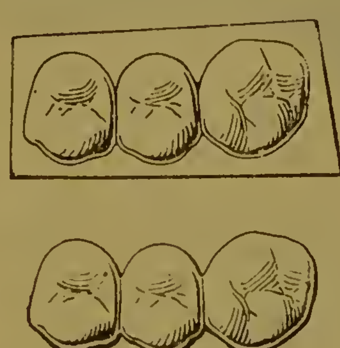


Fig. 783.

Fig. 784.

high on it, and make a counter-die with the same metal by pouring as cool as possible (Fig. 782). This gives the male and female dies with which to swage the continuous grinding-surfaces. Then proceed to swage the gold plate in one piece (Fig. 783), annealing as often as

necessary. Trim off the surplus plate (Fig. 783), and place in position on the articulator. Cut the cusps out on the buccal face to avoid showing the gold (Fig. 784), grind the porcelain facings to fit the cusps, and back with gold, No. 34 or 36, letting the gold come to the cutting-edge, the same as in a single crown as before described.

If there is a space between the cutting-edge and the porcelain, place a little wax in the joint to keep out the plaster investment, invest, remove the wax from between the joints, flux, and solder.

If it is desired to make an all-gold bridge, select the proper facings from the set, make a die of Melotte's metal, and swage up, the same

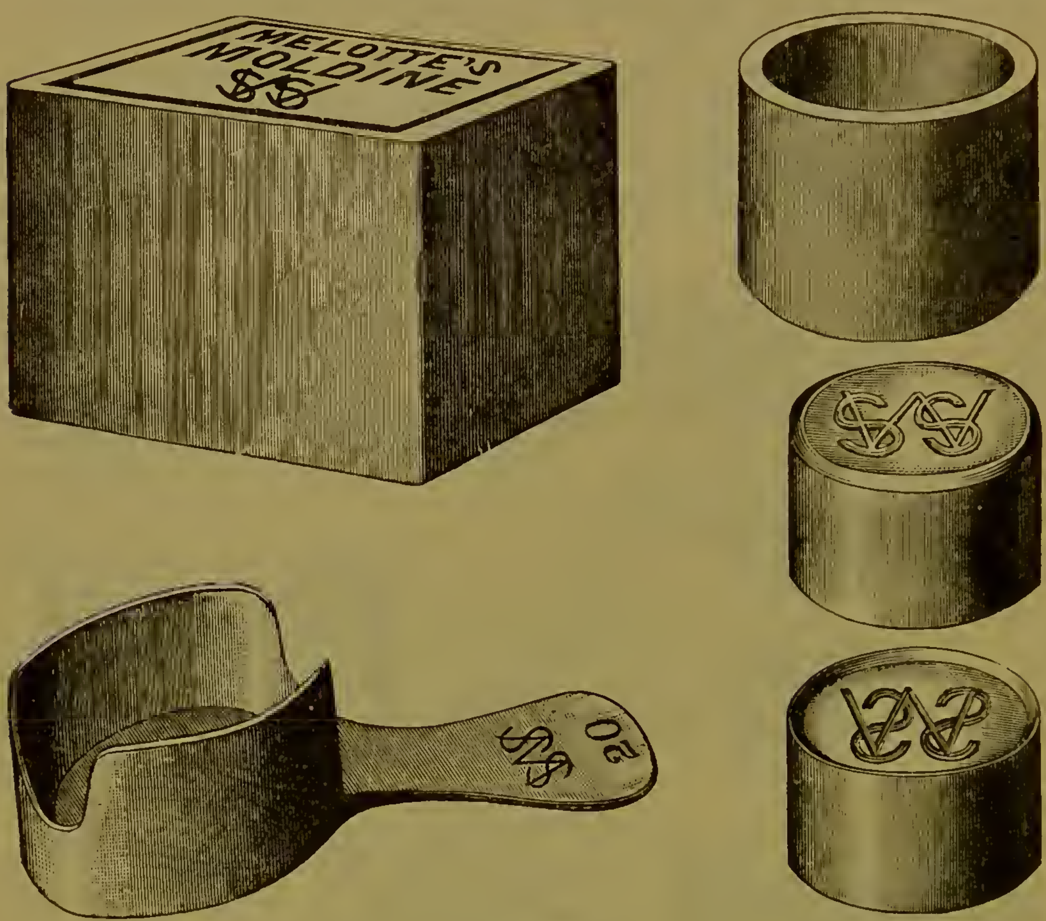


FIG. 785.

as in the continuous bridge before described, and mount gold facings in place of porcelain.

NOTE.—In case it is desired to mount a gold tooth on a vulcanite plate, select the proper form from the set, and make the crown as described. Solder pins on the back, and vulcanize to the plate in the usual way.

These strips will be found more desirable and practical than the ordinary binding-wire for taking measurements of roots, especially of badly decayed teeth. To use them, the strip is passed around the

tooth, and the joint pinched firmly with a pair of pliers. Where the decay runs under the gum, tack the ends of the strip together with soft solder, and with an excavator carry it well up under the gum.

Fig. 785 represents Dr. Melotte's moldine, impression cup, rubber ring, and fusible metal for crown dies and counter-dies. Moldine (molding sand and glycerin) is an impression material into which the metal can be poured as soon as the impression of the crown of a tooth is obtained.

Bridge Work.—Artificial Crowns Attached to Natural Teeth without Plates or Clasps.—These operations are generally known as "bridge-work," which is simply an extension of artificial crowns over the spaces made by the loss of natural teeth. The credit of first inserting artificial crowns to adjoining natural teeth, by fillings of cohesive gold foil, is due to Dr. B. J. Bing, who describes his method as follows:—

FIG. 786.

FIG. 787.

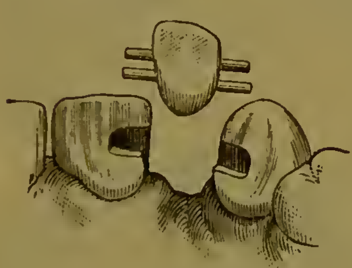


FIG. 788.

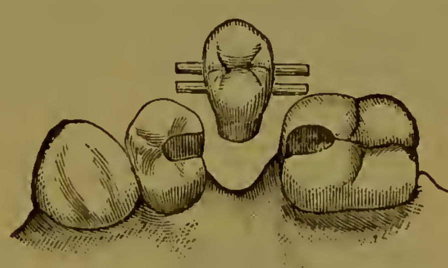


FIG. 789.

"In the case of inserting a central incisor, a cavity must be made in the palatine depression of the adjoining central, and also the lateral, and one in the approximal surface of either of these teeth, about the place where we usually find decay on these surfaces. An impression is then taken which will show these cavities, and a gum or plain plate tooth carefully fitted and backed with gold, observing the precaution of allowing a small point of the backing to extend into the approximal cavity. Two little griffes (bars) are then soldered to the base of the backing, the ends of which are carefully plugged into the palatine cavities with gold foil, in such a manner as will tend to draw these teeth very slightly together."

Figs. 787, 788, 789, 790, and 791 represent Dr. Bing's bridge-teeth. Fig. 789 represents porcelain crowns having two strong pins of

platinum baked in each side, the pairs of pins being so placed that the tooth when fixed in position is held firmly in proper relations to the adjacent teeth. Fig. 788 shows the supporting teeth prepared to receive a lateral incisor. Fig. 790 is a face view of the same in position. Figs. 789 and 791 show the same in the case of a bicuspid crown.

These crowns may be soldered to each other, or to collars and to cap-crowns, in the construction of every form of bridge denture.

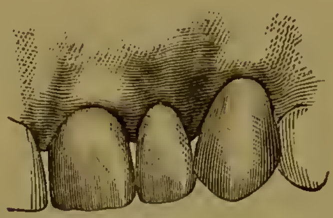


Fig. 790.

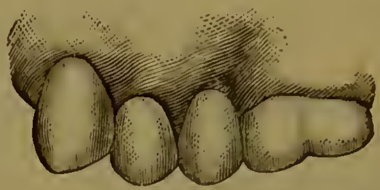


Fig. 791.

Dr. W. F. Litch has modified Dr. Bing's method, an abridged description of which, by Dr. Dexter, is as follows :—

"Supposing a left upper lateral to be inserted: Take an accurate impression of the parts (canine and central, and gum between), and make metallic dies from the model. Swage gold or platinum plates to very exactly fit the palato-approximal surfaces of the canine and central. Fit into the interspace a plain plate lateral incisor, slightly wider than the space to be filled, beveling and grinding the sides

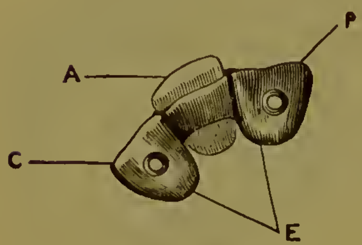


Fig. 792.

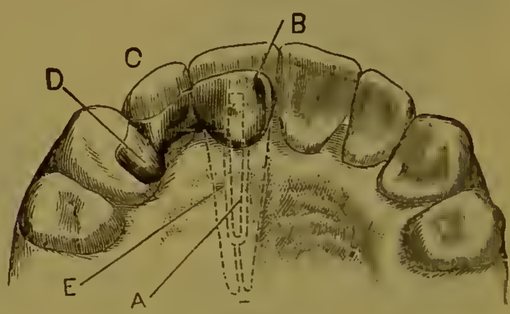


Fig. 793.

posteriorly, so that the tooth cannot be forced backward between its neighbors; the neck fitting accurately, but lightly, upon the gum. Back the tooth with gold. Place the prepared tooth and the struck plates upon a perfect model of the parts, and adjust the tooth backing accurately to the plates on each side. Cement together with shellac or other resinous cement; remove and complete the final adjustment in the mouth. Invest, and solder the tooth and plates together in their exact relative positions, observing to accumulate a large portion of solder over the joints (Fig. 792). The apparatus, if now placed in the mouth, will be found self-supporting against any force except the

perpendicular; for it cannot be forced backward into the mouth, owing to the extra width of the lateral; nor forward out of the mouth, owing to the wings or plates extending over the backs of the neighboring teeth; nor upward toward the gum, owing both to the porcelain tooth resting thereon, and to the converging planes of the plates or wings and the postero-approximal surfaces of the artificial tooth.

"The methods of final attachment are two, depending upon the case: 1. If one of the neighboring teeth is devitalized, attaching a pivot to the plate on that tooth and inserting it with gutta-percha, the plates themselves being covered with a film of the same substance on their dental aspects (Fig. 793). If the teeth are both alive, a modification of Bing's plan of filling, performed as follows:—

"The denture being constructed as before described, and polished, drill a cavity in the center of the palatal face of each tooth covered by the plates, slightly larger in diameter than the head of the pin in an ordinary rubber tooth, no deeper than the enamel, and undercut (Fig. 794 B). To each of these openings fit a platinum one-headed rivet, the head being very thin and perfectly flat on each side. Split the

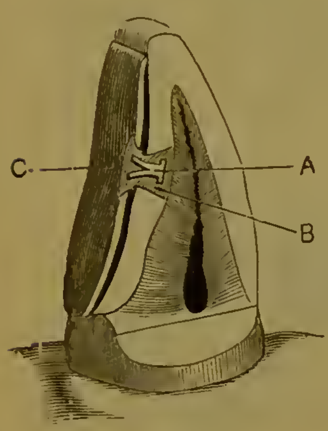


FIG. 794.

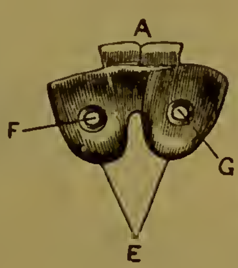


FIG. 795.

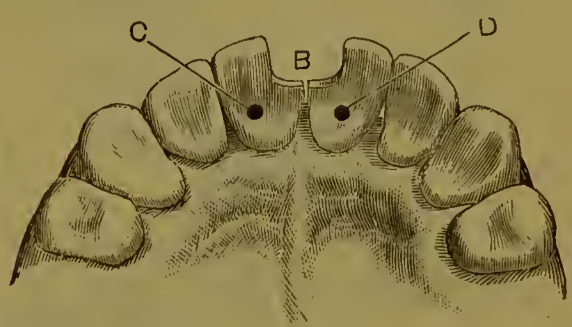


FIG. 796.

shanks of the rivets nearly to the head (Fig. 794 A). Make openings in the plates to exactly correspond with those in the teeth, and countersink them deeply on their palatal aspect. Place the gutta-percha on the dental surfaces of the plates, as described, and press the denture to its place in the mouth. When the cement is cooled and hard, remove that portion pressed into the holes in the plates and teeth, pass the rivet heads through the holes in the plates to their seats in the tooth cavities, and fill them in position with gold. When the fillings have reached the level of the tooth surfaces, spring open the split rivet shanks and continue packing gold around and between the separated parts and into the countersinks in the plates until flush with the plate surfaces. Cut off the surplus pivot shanks and finish (Fig. 794)."

Dr. Litch's method can also be adapted to the restoration of fractured angles of incisor teeth, as shown in Figs. 795 and 796, and which need no further description.

Fig. 797 represents a case of two bicuspid crowns secured to one root and two adjoining teeth.

The late Dr. M. W. Webb also modified the methods of Dr. Bing by forming an undercut groove in the porcelain crown in each side and along the cutting-edge, and filling gold foil solidly in the groove and slightly over the cutting-edge, to make the porcelain crown more secure than the platinum pins hold it, and to protect the edge from the occlusion of the lower teeth; also to build the crown into the approximal surfaces only.

Dr. Webb also described a method by which a crown without plate or clasps and where no root remains can be inserted: "After suitably forming the cavities in the proximate wall of each tooth next the space left by the loss of the one that had been extracted, a plain porcelain crown was fitted to the place and backed with gold plate. A portion

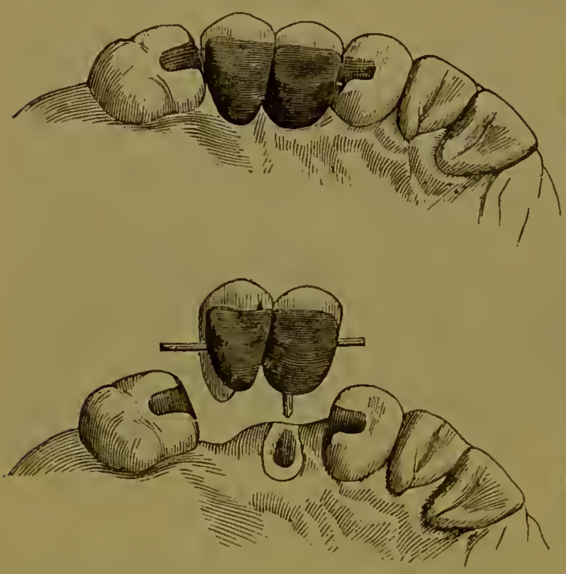


FIG. 797.

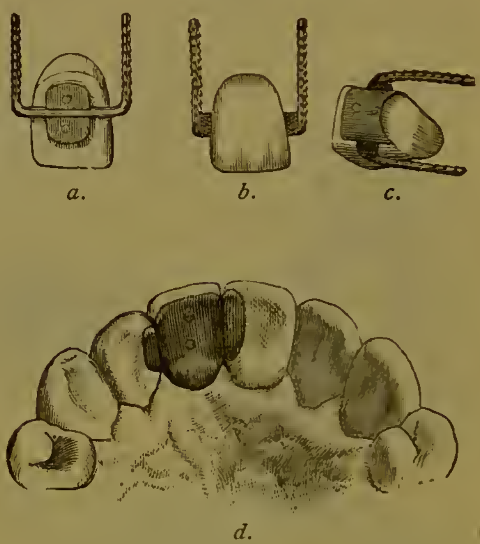


FIG. 798.

of the backing extended about one and a half lines from each side of the crown for insertion in the cavities prepared in the adjoining teeth, and to these parts a gold wire was soldered to fit into the pulp-chambers of the adjoining teeth. A small gold plate was then formed to fit upon the gum, covering as much space as was taken up by the neck of the natural tooth. When the backing was riveted to the pins in the crown and this placed in position, and while the whole rested on the small plate upon the gum, the backing and plate were so secured by wax that they could be removed intact and soldered. Each extended side of the backing and the surface of the wire was barbed, so that the gold foil would the better secure the crown when filled into every part. The crown with the gold attachments being ready for insertion, oxychlorid of zinc (or oxyphosphate) was placed in the pulp-

chambers of the adjoining teeth and the crown at once pressed to place. When the cement had hardened, a portion of it was cut away, so as to make proper anchorage for light, cohesive gold foil, which was impacted in small pieces around part of the wire and that portion of the plate extending into the cavities, and the crown was then secured."

To avoid any danger of the porcelain crown being broken from the platinum pins, Dr. Webb suggested that a groove be cut in each side, and along the cutting-edge of this crown (Fig. 798 *d*), so that gold foil may be impacted into it by means of a fine-edged corundum disc, after a heavy backing of gold plate and the wire have been fixed in place and soldered (Fig. 799 *a*). Into this groove the wire to connect the artificial crown with the natural teeth is to be placed (Fig. 798 *a*). When the operation of contouring the palatal surface of the crown

FIG. 799.

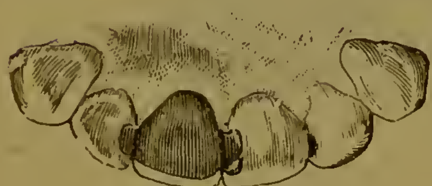


FIG. 800.

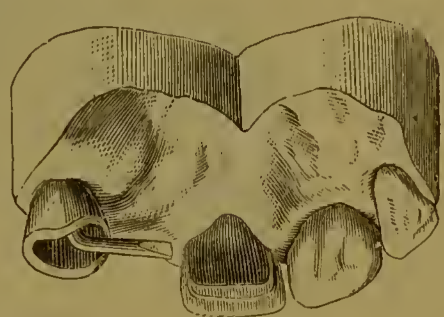


FIG. 801.

with gold foil is completed, the case presents the appearance shown by Fig. 800.

Dr. Webb also made use of a stout wire (No. 13), with a screw thread cut upon one end, for insertion into a devitalized tooth, and bent to receive the porcelain crown which was soldered to its free end, the wire being secured in place in the natural tooth by filling around it with gold foil (Fig. 801).

Figs. 802, 803, and 804 show an extensive operation performed by Dr. M. W. Webb, in which he made use of gold wire (No. 13) for bridging a lateral incisor, the natural tooth having been lost, and also the crown of the left cuspid, and disintegration having taken place in many of the teeth, and the front teeth abraded to the dentine. Fig. 802 shows the cases as prepared for filling, with the artificial crown attached to the gold wire in position, and gold screws inserted in the pulp-chambers of the cuspid and bicuspid teeth.

Fig. 803 shows the labial contour of each crown after the lost portions were restored with gold foil. Fig. 804 shows the finished case.

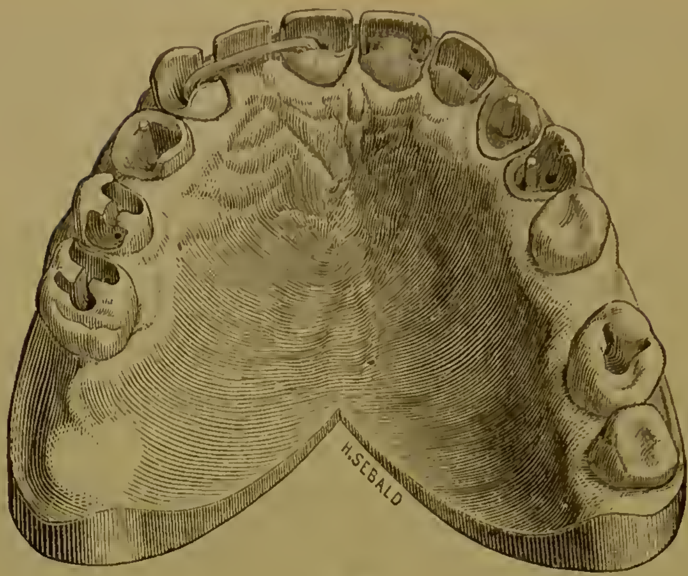


FIG. 802.

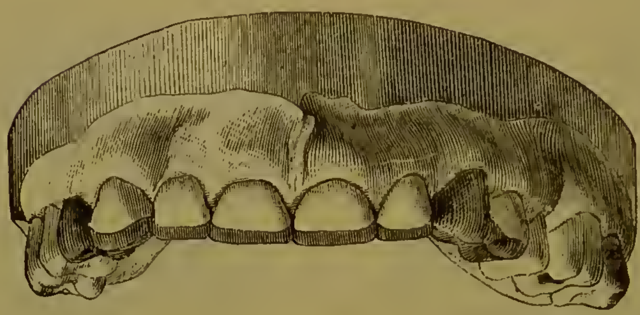


FIG. 803.

FIG. 804.

Finished case—*a*, *b*, *d*, *f*, *g*, and *h*, pulpless teeth; *g*, whole crown restored with gold; *a*, *f*, and *h*, almost entire gold crowns; the teeth *b* and *d* support the gold crown faced with porcelain, *c*, and fully one-fourth of the crown of each of these is restored with gold, as is also that of *e*, the pulp of which is living.

What is known as the "mandrel system" of bridge-denture is described as follows: *—

In all of the various systems of crown and bridge-work which have been brought to the attention of the dental profession, one very important point seems to have been overlooked, viz., the comparative conformation of the necks of different classes. The general forms of the crowns of teeth have long been well-known, but so far as we are informed no systematic classification of the shapes of the necks has heretofore been made. It would appear that such a classification ought to form the basis of any system of crown and bridge-work claiming a scientific foundation. To lay the groundwork of the system here described a large number of human teeth of the various classes were secured, their crowns cut off, and the shapes of the stumps accurately determined; thereby developing the fact that, no matter how great differences may exist in the apparent shapes of the crowns of individual teeth of a given class, there is a remarkable uniformity in the configuration of their necks. That is, the necks of upper cuspids, for instance, were found to have a fixed type, from which the variations were very slight as to shape, though there appeared to be no exact standard of size. So of the other classes, with the single exception of the superior molars, in which two distinct forms were found, the first being those in which the buccal roots were wider than the palatal; the second, those in which the reverse condition was found, the single palatal root being wider at its junction with the crown than the two buccal roots. The occurrence of roots of the second class being rather exceptional, the first class was accepted as the type.

The configuration of the necks of all the teeth having been determined, a set of mandrels for shaping collars to fit them was devised. The set (Fig. 805) consists of seven mandrels, six of which are double-end. Their shapes are modeled upon the general typal forms of the necks of the teeth which they represent, and they are made tapering to provide for all required variations in size. The illustrations are about two-thirds actual size, the longest instruments being nine inches in length. The cross-sections show the shapes and proportionate sizes at the greatest and least diameters. The long taper permits the most minutely accurate adjustment of the collar.

No. 1 is a double-end mandrel, for superior molars, right and left; No. 2 is a single mandrel, for superior bicuspids, right and left; No. 3 is a double-end, for superior cuspids, right and left; No. 4, double-end, for superior centrals, right and left; No. 5, double-end, for inferior molars, right and left; No. 6, double-end, for the inferior

* *Dental Cosmos*, Aug., 1886.

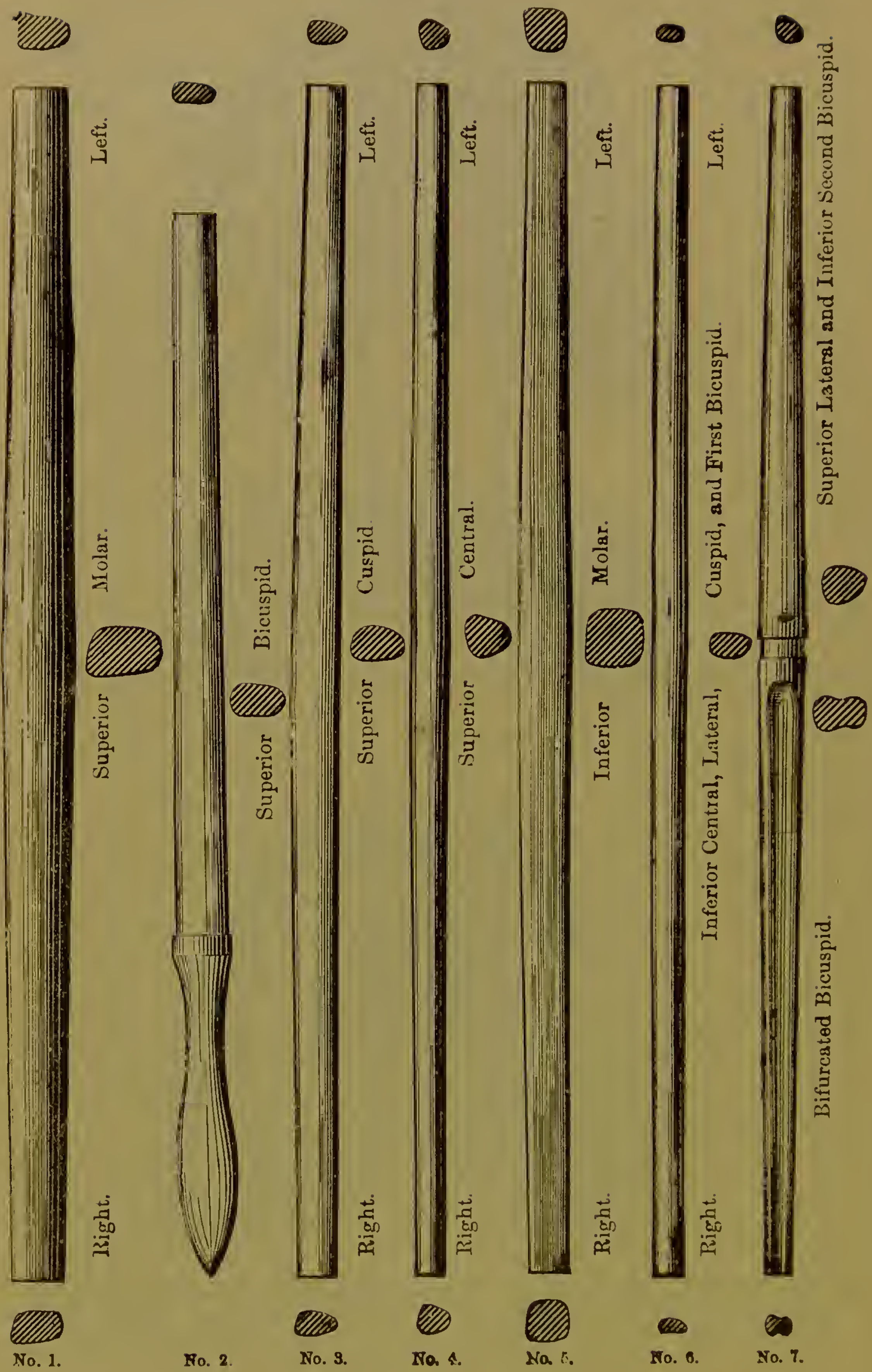


Fig. 805.—Mandrels for Shaping Seamless Tooth-Root Collars.

centrals, laterals, cuspids, and first bicuspids, right and left; No. 7, double-end, one end for the superior lateral incisors, the other for those bicuspids in which a bifurcation of the roots, or a tendency in that direction, extends across the neck to the crown, in the form of a depression on one or both approximal surfaces. The foregoing scheme comprehends all the teeth of the permanent set except the second inferior bicuspids. The necks of these approximate those of the superior central incisors so closely in shape that it was deemed inexpedient to make a separate mandrel, as the No. 4 mandrel will serve for both.

The collars or bands are made seamless, of No. 30 (American gauge) gold plate, 22 carats fine. Fifteen sizes, each of three widths ($\frac{1}{10}$, $\frac{2}{10}$, and $\frac{3}{10}$ inch) are made (Fig. 806), which it is believed will cover all requirements. These collars, although devised as a part of the system, can be used in all methods of crown and bridge-work which require bands, and possess many advantages over any others. They are really labor-saving devices, as their use saves the time and trouble of making, and there is no danger of their coming unsoldered when the pins or the backing of the crown is being soldered; and there are no hard spots to give trouble in burnishing, as, for instance, close to the root, after the collar has been shaped and placed in position, the whole surface being uniformly soft.

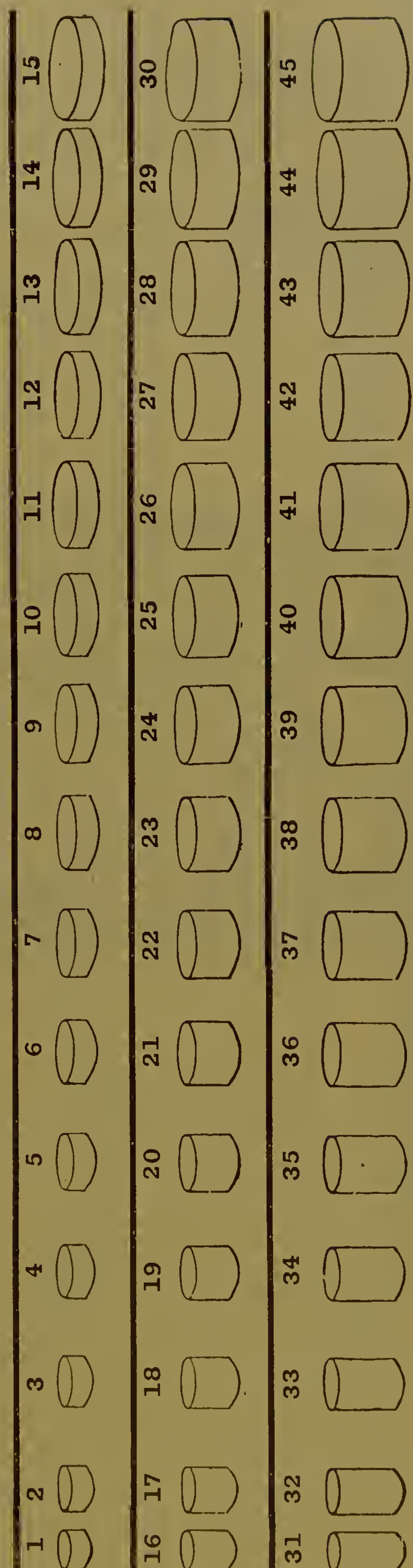


Fig. 806.—Seamless Gold Collars for Crown and Bridge-Work. (*Copyright, 1886, by the S. S. White Dental Manufacturing Co.*)

The seamless collars are also especially adapted to removal or detachable bridge-work. They are so constructed that Nos. 1, 16, and 31 exactly fit into or telescope with Nos. 2, 17, and 32, and so on through the entire set, each collar fits into the series next higher; so that a root may be banded with one size and the size next larger used to form the tube for the telescoping crown. Their advantages for the construction of cap crowns are obvious.

The other appliances specially devised for this system are, a reducing-plate or contractor, a pair of collar pliers, and a hammer.

The contractor (Fig. 807) contains holes which are complementary in shape to the mandrels. The mandrels being applied to the inner circumferences of the collars, while the contractor must admit the collars themselves, the short taper of the holes in the contractor neces-

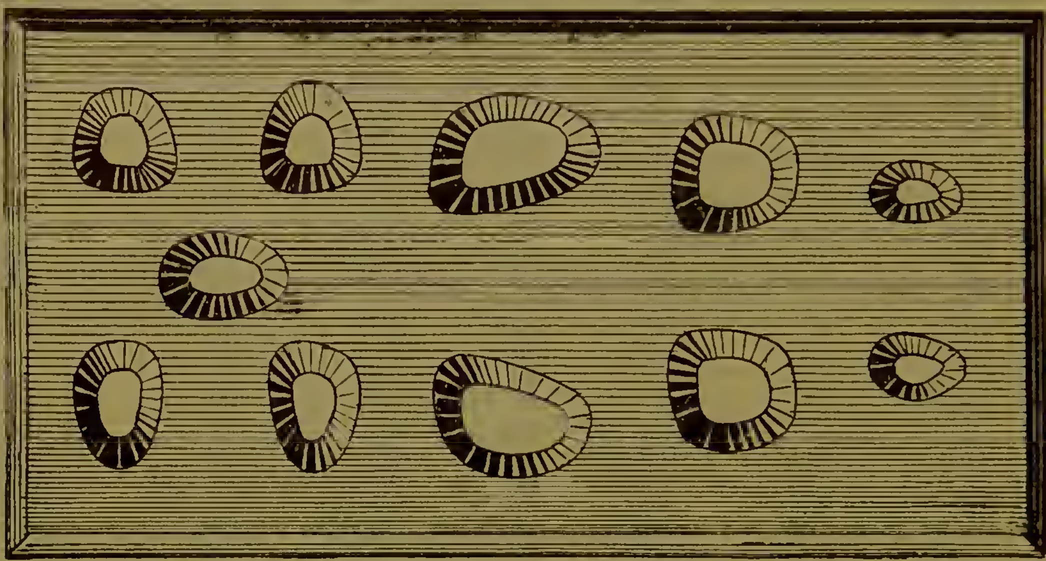


FIG. 807.

sarily covers a somewhat greater range of size than is shown in the mandrels. With this appliance collars can be evenly and accurately reduced in size at the edges, without burring or buckling. The illustration is actual size.

The collar pliers (Fig. 808) are for contouring the collars to shape, one beak being made convex and the other concave to correspond. With this appliance the slightest changes required in the contour of the collars are easily made. About a half inch from the extremity of the concave beak a small bar of flat steel is attached to it by means of a screw. The free end of the bar has a minute projection upon one face, the other being reinforced to fit into the concavity of the beak. In the center of the face of the convex beak is a depression, into which the projection on the steel bar strikes, making a very efficient punch for forming guards or stops to prevent the collars from being

forced too far under the gum. The depression in the convex beak being slightly larger than the projection or punch, the metal is not cut through, but merely raised on the side opposite to the punch. The punch attachment, being pivoted, can be swung to one side when not in use.

Fig. 809 is a mallet or hammer, with steel face and horn peen. The handle is 9 inches long.

One of the appliances required is a lead anvil,

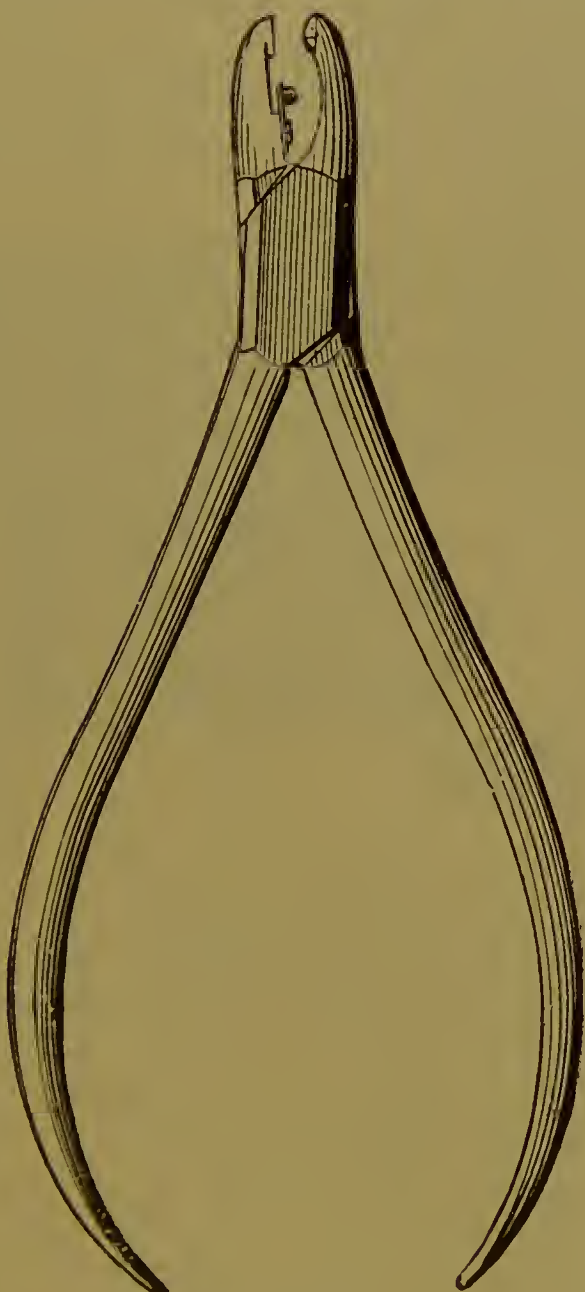


Fig. 808.

Fig. 809.

which, being only a piece of soft lead, say 2 x 3 inches and an inch thick, is not illustrated. The female die of an ordinary case will answer very well.

To illustrate the uses of these appliances, take a case in which two

inferior bicuspids of the left side are missing, and the crowns of the cuspid and first molar so badly decayed that the probabilities are that they will soon fall victims to the forceps. The old-time way would have been to extract the molar and cuspids, and make a partial plate. Examination, however, shows that the roots of these two teeth are in good condition, affording an excellent opportunity for the construction of a piece of bridge-work.

With a corundum point or rotary file, cut off the remaining portions of the crowns level with the gum margins. Prepare the roots in any of the well-known ways, thoroughly cleansing the apical portions and filling them with whatever material is desired, being careful only that the work is well done. For the better retention of the filling material to be placed in the pulp-chamber, retaining-grooves can be made or retaining-posts inserted. Take a piece of binding-wire (No. 26, American gauge), say 2½ inches long, pass it around the neck of the molar stump, cross the free ends, and, holding the wire in place with one finger, twist the ends with a pair of flat-nose pliers until the wire clasps the neck closely at every point (Fig. 810). Where there are

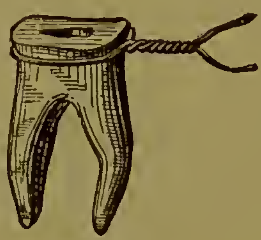


FIG. 810.

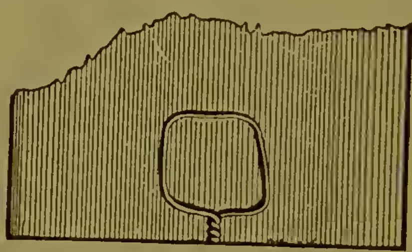


FIG. 811.

irregularities in the contour of the tooth, it is necessary to press the wire into them with an approximal burnisher. It is obvious that the ring thus formed will show the exact size and shape of the neck of the tooth. Remove the ring carefully, lay it on the lead anvil, put over it a piece of flat metal, and with a smart blow from a hammer drive the wire into the lead (Fig. 811). Upon removing the wire an exact impression of the ring will be left in the lead anvil. (This part of the work, as, indeed, all others, should be done carefully as described. The wire ring may be driven into the lead by a direct blow of the hammer face, but the blow might not strike equally, and the interposition of the flat metal held level insures an even impression. A piece of an old file is best, as the file-cuts keep the wire from slipping.)

Next, cut the wire ring at the lap, straighten out the wire, and select a suitable collar by comparing the length of the wire with the straight lines, which correspond in length to the inside diameters of the various sizes. Should none of these correspond exactly, take prefer-

ably the next size smaller. It will be remembered that the collars are No. 30 in thickness, while the wire with which the conformation is secured is No. 26. This difference permits the collar when contoured to shape to enter the lead impression readily, a decided advantage in fitting. Having selected the collar, fit it to mandrel No. 5, with the peen of the hammer, holding it upon the lead anvil, and using a slight pushing force to help in stretching and forming it (Fig. 812). Having driven the collar to form, remove it from the mandrel and try in the lead impression. If it does not fit exactly, return it to the mandrel and stretch it a little, when it will usually fit perfectly, as the mandrels have been designed carefully to the average shapes which obtain in the great majority of tooth-necks. In the exceptional cases where the collar does not fit it can be readily contoured to the exact shape with a pair of flat-nose pliers. Of course, if it fits the impression in the lead, it will fit the neck of the tooth, always provided the measurement and the impression have been carefully made.

If the collar or band has been accidentally stretched too much, or if for any reason when brought to shape it is too large, its root end

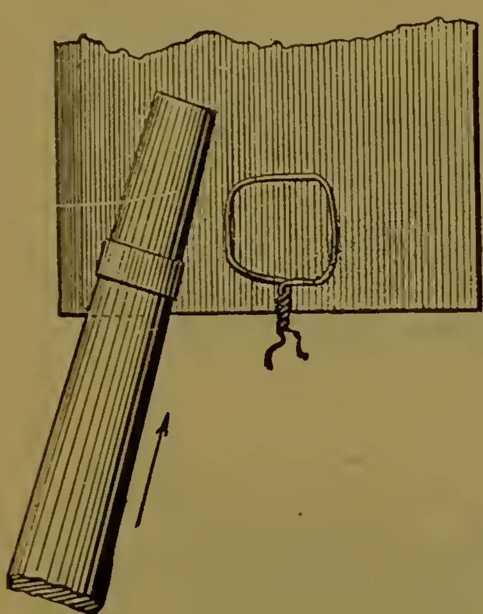


FIG. 812.

FIG. 813.

can easily be reduced to the proper size by the use of the contractor. Place the edge of the collar which is to fit the root in the proper hole; hold it level with a piece of file as in taking the lead impression of the ring, and tapping lightly on the file drive the collar into the plate (Fig. 813) until the proper reduction is made. The collar is next "festooned" to correspond to the shape of the "maxillary" ridge. Lay it, gum edge up, on the lead anvil, and with the piece of flat file and the hammer drive it into the lead. A few cuts with a fine half-round file across the approximal diameter will conform the edges to the surface of the ridge (Fig. 814). Then place the collar in position, and, having ascertained just how far it should go down on the root, remove it, and with the small spring punch in the collar pliers form projections on the inside of the band at the proper points to serve as stops, which, resting on the top of the root, will prevent the

collar from being forced further down upon it than is desirable (Fig. 815).

A collar for the cuspid is then fitted in the same manner, using mandrel No. 6 for shaping, after which the case is ready for the building of the bridge.

Place both collars in position and take an impression of the parts, including the interiors of the excavated pulp-chambers, from which make a cast in the usual way. Bend a short piece of half-round gold or platinum wire into the form of a horse-shoe, the two extremities of which shall fit into the roots of the molar. Then take a longer piece of the same wire, somewhat more than enough to extend from

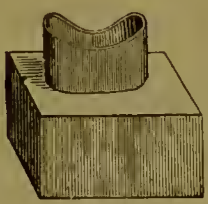


FIG. 814.

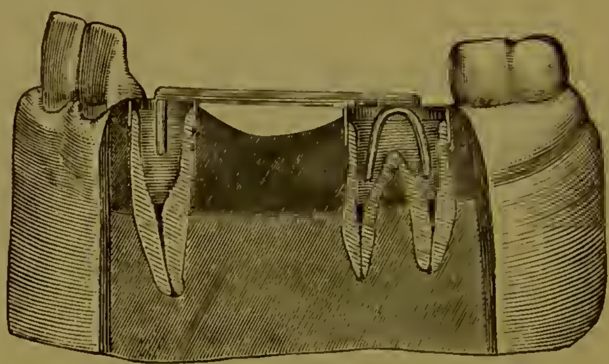


FIG. 816.

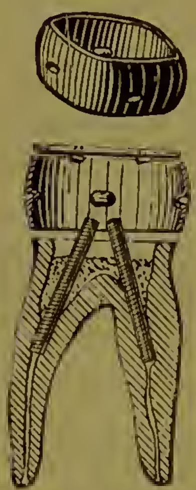


FIG. 815.

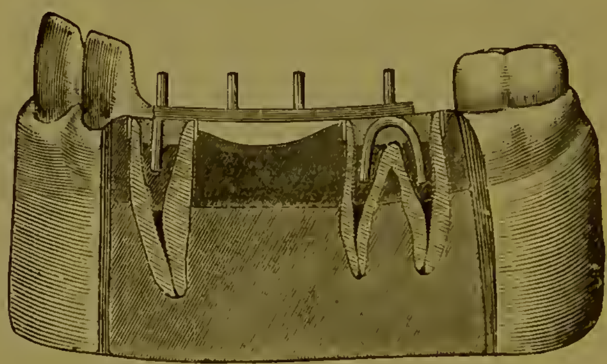


FIG. 817.

the toe of the horse-shoe when in position to the cuspid root; bend one end of it at a right angle, or nearly so, to fit the root of the cuspid, and (cutting off any excess of length) solder the other end to the toe of the horse-shoe. The bar extending between the two roots is the truss of the bridge. Next, place the appliance on the cast (Fig. 816), holding it in position with wax, and select the teeth to take the place of the missing bicuspids and molar. The best form for this purpose is a tooth having holes extending through it vertically from the neck to the grinding surface, similar to the well-known Bonwill crown.

The crowns used should be large enough to fill the space rather tightly, even if their sides have to be flattened slightly to let them in.

If the teeth do not fill the space tightly, a small portion of plastic filling material crowded between them, as mortar between the granite blocks in the arch of a railway bridge, will greatly increase the strength of the work.

After the teeth are ground to fit and the proper length for occlusion is ascertained, the truss is covered with a thin film of wax, upon which the crowns are again pressed to their positions. Upon the removal of the crowns the impression of the holes running through them will be found in the wax. At these points drill holes through the bar with a small twist drill run by the engine, and into these fit and solder the pins for the support of the crowns.

The bridge is now ready to be attached permanently. Set the crowns in position upon their supporting pins to secure the proper alignment. (If the operation were upon the upper jaw they would have to be held with wax). Put into the canals of the supporting roots (the cuspid and first molar) a sufficient quantity of some quick-setting plastic, as oxyphosphate, to about half fill the pulp-chamber, but not enough to prevent the supports of the truss from being forced home. Force the bridge supports to place, and after allowing the filling material to become set remove the crowns. Fill the remainder of the pulp-chamber and the whole of the collar with gold or with amalgam, gutta-percha, oxyphosphate, or any suitable plastic (Fig. 817). Set the crowns permanently, the molar and cuspid first, as this affords greater facility for the trimming off of any excess of the filling material used in the attachment. For attachment of the crowns, gutta-percha is probably the best material, as crowns set with it are readily removed for the correction of any inaccuracies of occlusion or alignment, by grasping them between the beaks, previously warmed, of a pair of universal lower molar forceps. The heat warms the gutta-percha and releases the tooth, which can then be re-set properly. In attaching crowns with gutta-percha the holes in the crowns are first filled with the material, after which the crown is warmed and forced to place. Any of the other plastics ordinarily used in setting Bonwill crowns can be employed at the discretion of the operator. Fig. 818 shows the case completed.

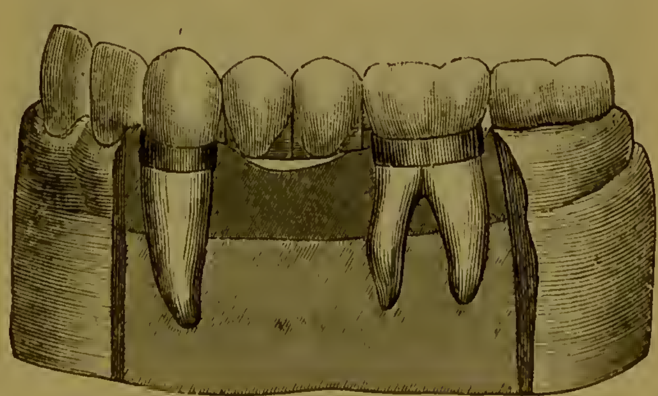


FIG. 818.

In securing the occlusion of a piece of bridge-work it is well to

make the artificial teeth a little short, so that the natural teeth on both sides will meet the first shock of mastication. Nature will correct the occlusion in time by slightly elongating the roots supporting the bridge. If the artificial crowns are permitted to strike the natural teeth from the first, the undue strain upon the two supporting roots may cause soreness and perhaps more serious consequences.

When a sound tooth is to be used as one of the supports of the bridge, a modification of the method just described is necessary. Take a case where it is desired to bridge the space caused by the loss of the right inferior bicuspids and first molar. The crown of the right cuspid is nearly gone, but the root is sound and capable of supporting one end of the bridge. The other end will be attached to the second molar, which is a sound tooth. Prepare and band the cuspid root as before; dress off the second molar crown until it is slightly smaller than the neck, so as to permit a cap to be telescoped over it, and take the measure of the crown with the binding-wire. Select a suitable seamless collar of sufficient width to extend from the neck to a little beyond the grinding surface, and drive it up on the proper mandrel to get the general shape, but not the full size required to fit the tooth, leaving it so that the edge having the larger circumference will just pass over the end of the crown; place the collar on the tooth, and with a block of wood and the mallet tap it to place just beyond the free margin of the gum. This method will make a close fit, as the collar will readily stretch all that is necessary. With a sharp-pointed instrument mark the length of the crown, remove the collar, and cut it to the proper width as indicated. Then in a piece of gold plate of the thickness used for caps form four little depressions of the general character of an impression of the molar cusps. An easy way to do this is to lay the plate on the lead anvil; then with the ball on the end of an ordinary socket-handle and the hammer the depressions are made in a moment. Set the collar on the plate, borax it, charge with solder, and heat till the solder flows. Cut off the surplus plate, and a perfect cap for the molar is made. Place it on the tooth and take an impression, and thereafter proceed as before directed to make the truss of the bridge and mount the teeth, except that in this case the posterior end of the truss is to be soldered to the molar cap. For the

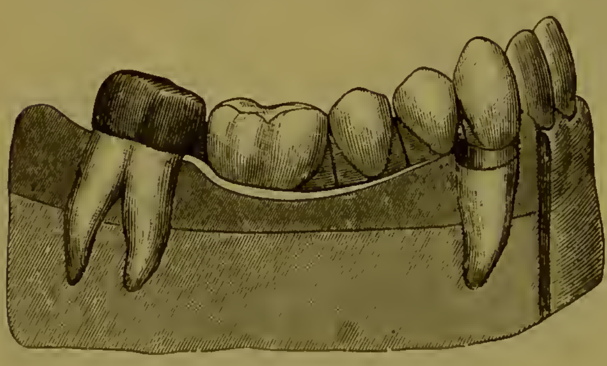


FIG. 819.

final attachment place a little oxyphosphate or any other plastic filling material in the cap to secure it firmly (Fig. 819), first cutting a slot in the crown end of the cap for the escape of the excess of material. Pressure upon the filling material hastens its hardening.

Detachable Bridge-work.

A description of two or three methods of constructing detachable bridges will suffice to indicate the general principles involved. Having these, each operator will find it an easy task to devise the modifications necessary to adapt a method to individual cases.

The first method is especially applicable to cases where both ends of the bridge are attached to roots—as, for example, the inferior cuspid and second molar roots of the right side, the intervening teeth having been lost. The operation is conducted as described in the first case of fixed bridge-work down to the construction of the truss, for which in this method square gold wire is used. Having cut the wire of the proper length, lay it upon a piece of gold plate (about No. 29, American gauge) of the same length and full three times as wide, and placing the two upon the lead anvil, with a hammer and the piece of file before used drive them into the lead. This will form the plate into what we may call an open trunk, which fits the square wire. Remove the two from the lead together, and, without separating them, curve to the proper shape to form the truss. Grind crowns having vertical holes, like the Bonwill, to fit, and having determined the proper points for the supporting pins, by the method already described, drill through both trunk and bar at these points. Separate the bar from the trunk, and fit and solder pins to the bar. Construct small tubes to fit the pins, ream out the holes through the trunk to admit them, and set the tubes with solder in the enlarged holes (Fig. 820). Fix the crowns permanently upon the tubes. They may be mounted in any of the approved ways, by vulcanizing or by the use of a plastic filling material. When they are firmly set, place the trunk with the teeth upon the bar, and anchor permanently as already described. Fig. 821 shows the completed work.

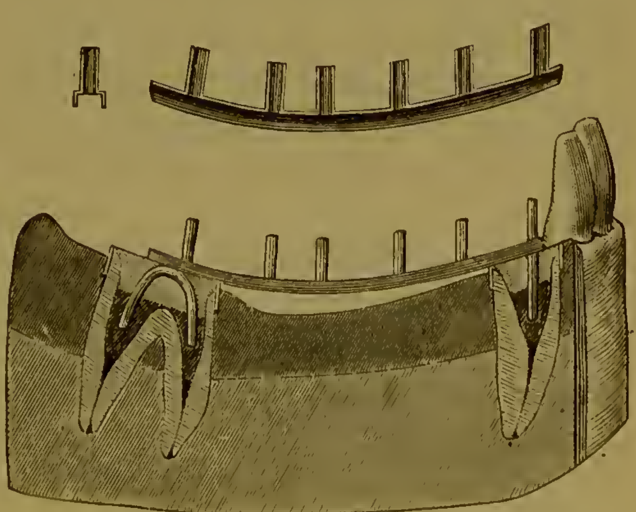


Fig. 820.

In this method the truss consists of the bar and the open trunk which covers three sides of it. The bar is, of course, permanently attached to the roots of the molar and cuspid, but the trunk with the teeth can be removed at any time.

The second method of constructing a detachable bridge is applicable to cases where one or both of the supports or piers are sound teeth. In the case adduced for illustration the right inferior cuspid crown was decayed, and both of the bicuspids and the first molar were absent. The supports for the bridge were the sound second molar and the cuspid root. After the cuspid root was prepared and banded, the crown of the molar was reduced very slightly,—not sufficient to destroy the enamel, but just enough to permit a collar properly fitted to pass over it. A collar somewhat wider than the length of the crown from grinding surface to neck was fitted and cut to the proper width. Two lugs were then soldered upon the anterior and posterior sides and bent to fit into the approximal fissures which were slightly cut out to admit them. An impression was taken, the collar coming away in the plaster, and a cast was made with the collar in position. A coned tube was then made for the root of the cuspid and a coned pin fitted into it. A truss of half-round wire was made, to which the coned pin and the molar collar were soldered (Fig. 822). A half-clasp to grasp the lateral was next soldered to the end of the truss to be supported by the cuspid. The object of this clasp was to guard against the teeth being thrown out of proper alignment by the force of mastication. Bonwill crowns were then vulcanized to the truss, after their supporting pins had been fitted and soldered to it. (Countersunk crowns can be used as well in the same way. Plain plate teeth may also be used in this style of work, in which event they are to be soldered to the truss.) The bridge was then ready to be set, which was accomplished in the following manner: The cuspid root was nearly filled with oxyphosphate, and the coned tube was placed upon the pin. The band was put on the molar, and the coned pin with the tube upon it was forced into the plastic in the cuspid. As soon as this became set, the tube was held permanently, while the bridge itself could be removed whenever desired (Fig. 823).

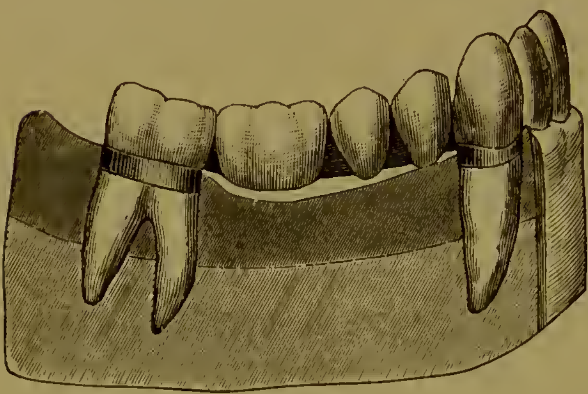


Fig. 821.

This method of fixing the tube allows considerable range in its

adjustment. In soldering the coned pin to the truss, care should be taken to set it at an angle exactly parallel to the axis of the molar; otherwise there will be difficulty in removing the bridge.

The third style of detachable bridge-work to be described involves the use of cusp crowns (Fig. 824) for supporting posts and piers. Suppose a case where both ends of the bridge are to be attached to inferior cuspid and second molar roots, the intervening teeth having been lost; the bridge is, therefore, required to extend from the right

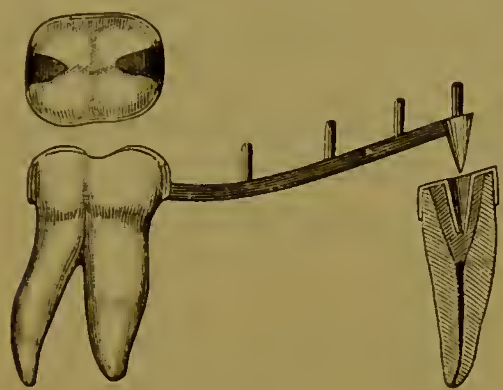


FIG. 822.

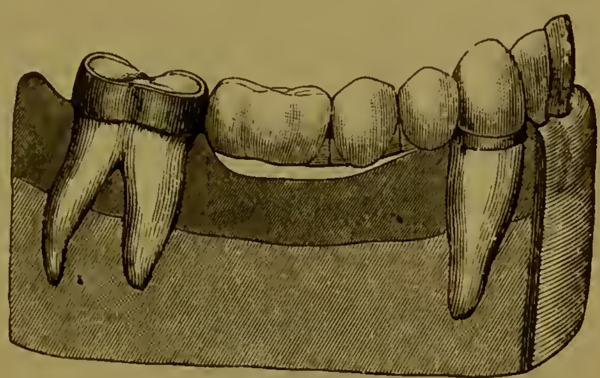


FIG. 823.

inferior cuspid to the right inferior second molar, with only the roots of the two teeth named as supports. Prepare the roots and pulp-chambers. Set screw-posts into the dentine for anchorage or as retaining-pins, and fit the collars, using sizes wide enough to form the walls of the crowns. Fill the pulp-chamber and about two-thirds of the depth of the collars with a plastic filling material, packing it well around the retaining posts. Select suitable cusp crowns for the molar and cuspid and place them in the ends of the bands to ascertain the

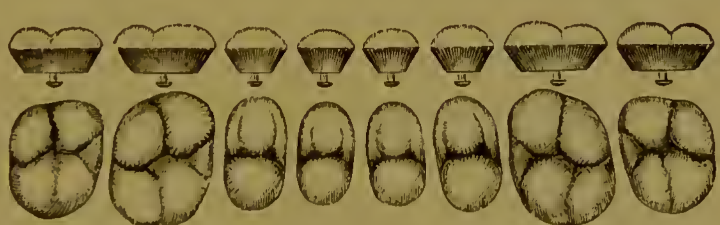


FIG. 824.

occlusion. If too long, shorten the cusps or reduce the bands with engine corundums or rotary files, and when the correct articulation is found form a small, square shoulder in the lingual edge of the cuspid and in the posterior grinding surface of the molar. Fill the remaining portion of the collars with plastic mixed somewhat thinner than the first lot, and set the cusp crowns in position. If there are antagonizing teeth the mere closing of the patient's jaws will force the crowns to place. If there are no antagonizing teeth the crowns can

be readily tapped to place with the mallet, using a piece of wood as a driver. Allow the filling material to set firmly, trimming off any excess which may exude around the collars.

Bridge supports or piers constructed on this plan are strong and durable, and likely to withstand any strain. Take an impression, and proceed to fit seamless collars to telescope over those already set upon the cuspid and second molar roots. It will be remembered that these collars are so made that each size telescopes into the next higher series. If the proper sizes are selected for the outside or female bands, the work of fitting is readily and quickly accomplished, forming tubes which slide easily over the supporting piers, and at the same time fit closely. It is only necessary to take care in shaping the tubes not to drive them too far up on the mandrels, and thus stretch them so as to destroy the fit. To the outer end of each of the tubes solder a small

Fig. 825.

Fig. 826.

piece of gold plate, forming partial caps so placed as to rest when in position upon the shoulders previously cut in the cusp crowns. Adjust a truss bar of half round gold wire, to the ends of which solder the tubes (Fig. 825). The truss is now ready for the teeth, which may be of any of the forms used for this purpose, and they may be attached to the bar in any way desired. One of the strongest attachments is vulcanite.

An easy modification of the plan just described is readily adapted to cases where only a small space is to be filled and one end of the bridge is to be supported by a sound tooth. Thus, suppose it is desired to bridge a space formerly occupied by the two inferior left bicuspids, the crown of the first molar being a mere shell. The operation would be essentially the same as in the previous case, except that the sound cuspid would be utilized for one of the piers as follows:

Fit a seamless collar, cut out a portion of it so that it will embrace only about two-thirds of the cuspid crown, and solder a partial cap or cover to it, as illustrated in Fig. 826. Or, if deemed preferable, the cuspid may be separated from the lateral incisor with the corundum disc and the collar allowed to embrace the whole crown.

The great desideratum in constructing a piece of bridge-work is, of course, the securing of perfect usefulness in mastication and speech, combined with absolute comfort and cleanliness. The closer a bridge approaches that condition where its wearer loses consciousness of its presence in his mouth, the nearer perfection it is. Scarcely less important, however, is the necessity of providing for repair. Accidents will occur, and the system which superadds to usefulness, comfort and beauty, ready facilities for repairing breakages, is by so much superior to those which make no such provision. A crown broken from a bridge constructed by any of the methods above described can be easily substituted, and the piece when repaired will be as strong and serviceable as it was originally.

It has not been deemed necessary to detail the construction of a single crown separately, as all the steps are included in the building of bridges, which have been described minutely. Porcelain cusps of the general form illustrated in Fig. 827 have been designed specially for these cases. In mounting them the gold band is cut away on the buccal side as shown in Fig. 828 to permit the porcelain to show.

Dr. C. M. Richmond, of New York City, in making removable dentures of the entirely soldered kind, employs a zinc die made from a cast of the anchor tooth with its cap on. He makes of crown metal (platinum faced with gold) a collar somewhat smaller than the tooth-cap, and deep enough to reach from the gum to about a sixteenth of an inch above the cap. He then drives the die into the collar so far that the extra sixteenth of an inch can be hammered over and burnished down on the die-end to form a flanged collar. Outside of this, in the same manner, he forms another flanged collar, and then solders the two together, thus obtaining a close-fitting stiff collar, that will not stretch in being telescoped on and off the anchorage, and is kept by the flange from being forced too far over the tooth-cap. A denture of this kind is illustrated in Fig. 829, which also shows his post and roof device in another form than that previously described.

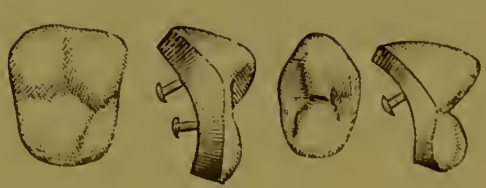


FIG. 827.

It may be well to add that, in the use of an impression cup for holding the plaster and sand around the parts to be subsequently removed

from the mouth, the *inside* of the cup should first be slightly oiled, to allow a separation of the cup when the mass is being prepared for the soldering.

A removable bridge-work is suggested by Dr. T. S. Waters, which is described as follows: "The natural molars and bicuspids, one or more of each class, are capped with gold crowns, each molar being double capped, and the outer cap containing two small springs constructed of small strips of elastic metal (gold and platinum), one end of each spring being soldered to the inner surface of the cap near its base at the neck of the crown, and the other end free to press on the side of the inner cap. Such springs retain the outer cap fitting over the inner one on the prepared natural crowns by their pressure on the sides of the inner caps, the latter being cemented to the natural crowns.

"The band for the natural bicuspid crowns has two shoulders on

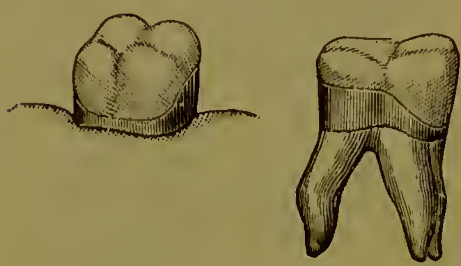


FIG. 828.

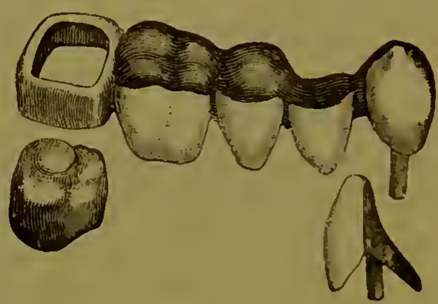


FIG. 829.

the inside which fit into grooves cut in the mesial and distal surfaces of the gold forming the crown."

Dr. James W. Low, the inventor of what is known as the "Low method of bridge-denture," describes it as follows:—

"My experience has convinced me that, as a rule, a tooth firm in the jaw need not be extracted. There are but few exceptions. When the treatment is followed persistently, and proper judgment used, nearly all the partial loss of the teeth can be restored without covering the roof of the mouth, and made as valuable for masticating food as the natural teeth, I am positive, and with less injury to the remaining teeth, than by any other method. The method referred to is that known as the 'Low method,' or bridge-work.

"Bridge-work consists in supplying vacancies between teeth or roots with artificial teeth, attached to the adjoining natural teeth or roots by means of bands or crowns, and held in such position that there is no contact with or pressure on the gums beneath, and thus no opportunity for secretions or other foreign matter to be held there and thereby become offensive.

"There is really but one kind of bridge-work, and but one way to

make bridge-work to insure success. There are many ways of making teeth without plate, but this is not bridge-work. I will here try to explain in detail my manner of making and adjusting bridge-work.

"For the first illustration, as seen in Fig. 830, we have a case where all the teeth have been extracted, except the two cuspids and two second molar roots.

"We first proceed to prepare the roots by crowning. I use gold crowns on the molar teeth, and what is known as the Low crown on the two cuspids.

"The preparation of the two cuspids consists in making the crown ready for adjustment. I always measure the tooth to be crowned with gold with a strip of block tin, 35-thick stub gauge or thereabouts. Place the tin around the tooth, and with pliers carefully measure the full size of the same.

FIG. 830.

"Should you be measuring a tooth, or part of a tooth, on which there are projections, take the engine, and with a stone grind off the same, making a smooth surface, so there will be nothing to interfere with the fitting of the bands properly. After cutting the tin measures by the marks made by the pliers you have the measures ready to make the gold bands by. Cut the bands and bevel the edges, and solder together, and you are ready to fit. After fitting all the bands, and finishing the crowns in the usual way, I place each in position in the mouth, having previously regulated the articulation of each crown as desired, in the process of making. We now take a deep articulation in wax, and impression in plaster of Paris; remove before it gets too hard, and place all the crowns in their positions in the impression; varnish, oil and pour in the usual way; separate the cast from the impression and place in the articulator. Then pour plaster. After the

plaster has hardened, remove the wax and we have the articulation proper, and are ready to select and grind our teeth, having previously selected our shade. My experience has long ago taught me that no porcelain teeth can stand the pressure for bridge-work, the strain on them being twice as great as with teeth on plates, which rest on the gums that give to pressure. In order to prevent breakage of teeth and give strength, I have for many years been making a tooth with gold cusps. I will here describe my manner of doing so. I had some shells of bicuspids and molars made, or rather teeth, without the crown. They can now be found in some of the depots.

"For the first step, I use 28-gauge platinum for a covering of the inside of the shell, or just where you wish gold to flow. Then I bend the pins down to hold the platinum in position, and with a file remove all overlapping platinum to prevent breaking of our tooth in heating. The tooth is made flat on the crown surface with the express intention of restoring with a gold crown. This crown need not be very thick, but should perfectly resemble the cusps on the natural tooth, for the purpose of mastication. As these cusps are not on the market, and every dentist making bridge-work cannot make it in a way to stand, without putting gold cusps on the grinding surface of the bicuspids and molars, I will here describe, for the benefit of those who do not know how to make them, how they can be made with very little trouble. Pick out a natural tooth with cusps the exact shape you wish to have your gold cusps, mix some fire-clay in a thick paste, then press your tooth into it a little deeper than you wish the cusps. Having made the proper impression, remove the tooth, and set the impression over the gas stove to dry. After it is dried and reasonably hot, lay your pieces of gold in the impression and, with a blowpipe, melt them. When melted, press with a piece of steel on the gold till cool. This mold will do to make many from. If you have not the fire-clay and can get charcoal that is burned from fine-grained wood, and is soft, you can simply press your tooth into the charcoal and melt in the same way, or you can carve your teeth as you desire in a block of carbon. Of course the little steel dies are handier, as we can swedge up our gold cusps in them, either solid or thin.

"Having described our manner of making the cusps, we will now return to the manner of finishing our tooth. We left off by saying we covered the inside and bent down the pins and filed off the overlapping platinum. We now place the cusp on the top of the tooth, and place in the position desired, holding it there with wax, and with a spatula trim the wax the exact shape we wish our tooth to be, V-shape, tapering from the crown down. We now encase in plaster and sand, which gives us a box. When hard, remove the wax and place

over the stove, and when sufficiently dry fill in with coin gold, using the blowpipe to melt it in a solid mass, and then our tooth is ready to file up and place in position on the articulator. Fig. 831 shows the tooth in this condition.

"After our teeth are all arranged we hold the same in position with wax, remove from the articulator, encase with plaster and sand or asbestos in the usual way. That we may have a strong case, I always use platinum wire between each tooth, and then proceed to heat and solder. Be sure that all the gold cusps are so arranged that you can

Fig. 831.

Fig. 832.

get all soldered together, as this gives us great strength. My formula for solder, which I have used for many years and which will be found very easy-flowing and almost the exact color of the gold you are using, is as follows: Always figure from the carat of gold you are working. Take one pennyweight coin gold, two grains of copper, and four of silver. We now have our case soldered; after filing as desired, commence to finish with felt wheels and pumice stone, after which we use rough buff wheels. We are now ready to adjust in the mouth. In Fig. 832 we see the case ready for adjustment.

"Have the assistant dry all the teeth or roots to be operated upon while you are mixing the cement. Be sure and use a kind which does not harden very rapidly, or your cement will set before you get your teeth adjusted. Use sufficient cement to fill all the gold crowns perfectly when the case is driven to place. Moisten the step plugs and cap with cement, touching every portion, and with an instrument place a little cement in the bottom of the cavity. We now adjust our case, using the little rotor for the low crowns, and a piece of ivory for driving on the gold crowns. Fig. 833 represents the case when in position.

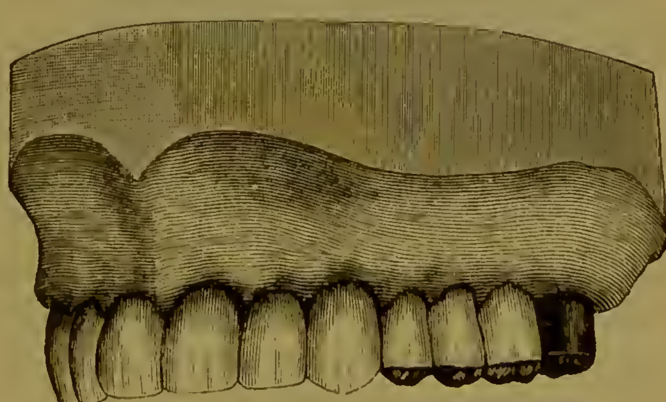


Fig. 833.

"It will be seen by looking at the previous cut (Fig. 832) that the teeth, after having been soldered, are all spaced fully one-third of the distance from the place of contact with the gums and the grinding surface of the teeth, so that secretions could not possibly lodge there. I have given you a description of my manner of making a full upper case of bridge-work where there are roots to be crowned to support the bridge. I will now describe my manner of operating upon a case where the four centrals are missing, as seen in Fig. 834. To supply these four teeth where the cuspids are intact, I use a gold band.

"I first measure the tooth with strips of tin and make the gold bands as before described, cut out the outside lower portion of the band before beginning to fit. In fitting, as the band is being driven down, cut away any of the band that touches the gum before all touches; never drive the band under the gum, as inflammation would probably follow.

"I mention this, as I have seen many attempts to get rid of the band by driving up under the gums and cutting them out on the front, until

FIG. 834.

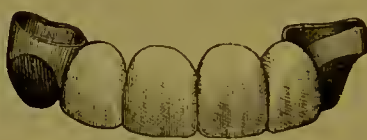


FIG. 835.

they were too narrow for strength. It is hard work to make something out of nothing. The bands should be heavy and strong, and the patient made to understand that if he expects to get rid of the annoyance of the plate he must sacrifice his dislike to showing gold. After driving the bands up close to the margin of the gums, as the cuspid teeth are very tapering, the bands will have to be taken in at the bottom. To do this I slit the band about a third of its length up, then place it on the tooth again, lap it over enough to bring it to a close fit, and then take it off and solder.

"Continue taking it in wherever it does not perfectly fit the tooth, and after a good fit is obtained proceed as before described by taking an articulation and impression. In adjusting first try the case on to see that it fits and that the articulation is all right. Fig. 835 shows the case ready for adjustment.

"Next, have the assistant dry the teeth upon which the bands are going, and then mix your cement. This should be mixed to about

the consistency of thick cream. It must be neither too thick nor too thin, or the adhesion will not be strong enough to hold. Cover your teeth with cement and then the inside of the bands. Place these on the teeth and carefully mallet up into position. For this purpose I use a steel instrument with a crease or groove in the end. The teeth must be kept dry after the case is in position until the cement is well set. After this is done bevel the edges of the bands and burnish close to the teeth, and if properly done they will be made to resemble gold fillings.

"In Fig. 836 we have the case completed.

"I am aware that in a case like this, porcelain crowns instead of gold bands could be used, and I should consider it much preferable to do so where we have roots or unsound teeth to operate upon, but do not advise the destroying of nerves where the teeth are intact to supply such a case with crowns, as the bands will answer every purpose for many years.

"If they should give out in after years, the roots can then be crowned. I have many of these cases that have been in use seven and eight years, some of which have never loosened, and some I have reset nearly every year. I always impress upon the patient the necessity of having them reset immediately, should they become loose, and advise them to have their cases examined at least once a year. Should parties insist upon having crowns used to supply a case like the one just described on perfectly sound teeth, I should begin by using an aluminum disc, with corundum, cutting deep as possible, both on the labial and lingual sides. Then use the excising forceps. This can be done under the influence of an anesthetic or otherwise. It is not by any means so painful an operation as one would think. If the nerve does not come out with the piece of tooth cut off, I take a piece of orange wood which I have previously cut the proper shape to drive into the nerve canal. I place it in creosote and let it soak a few minutes before beginning to operate. Immediately after severing the tooth, drive this into the canal, then remove, and dip in creosote and drive in again. This will perfectly fill the nerve canal; all sensitiveness will disappear, and you can begin to operate at once. I do not

FIG. 836.

recommend this treatment for sound teeth, but I have treated many exposed nerves in this way; also many teeth broken by accident, and think this the most satisfactory way to dispose of such cases. I have never had any unfavorable results follow after operating upon teeth in this way, and I can hardly say as much in favor of any other treatment. I speak of this manner of treating exposed nerves as one of the operations that sometimes become necessary in adjusting a bridge properly. I do not claim any originality in this mode of treatment. I know several dentists who use this method, all of whom report satisfactory results. We now have Fig. 837, showing the roots prepared to receive the case.

Fig. 837.

" I have many of these cases in use that are giving entire satisfaction. The instrument selected for preparing these roots should be one with small inside cutters and large bevelers, so as not to cut away any more tooth-substance than possible.

" Fig. 838 represents the case ready for adjustment.

" Fig. 839 represents the case after adjustment.

Fig. 838.

Fig. 839.

" In this article I have described my manner of making teeth for bridge-work, and I am now using a tooth made expressly for this work.

" The following, Fig. 840, shows us a socket. These are ready made in various sizes in bicuspids and molars with corresponding shells.

"Figs. 841 and 842 represent the shells placed in sockets. Fig. 841 is a molar tooth showing the shell in position, and 842 is a central reversed.

"Fig. 843 represents the socket as made for the four central and two cuspid teeth. The advantage of these teeth can readily be seen, not only for bridge-work but all gold plates. A tooth, if broken, can readily be replaced without removing the bridge or cracking by soldering, and with only a small expense.

"Fig. 844 represents the shell placed in position in the socket,


FIG. 840.

FIG. 841.

FIG. 842.

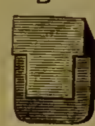


FIG. 843.

FIG. 844.

which can be used for bridge- or crown-work, and will greatly reduce the labor in making either."

Dr. G. W. Melotte describes his system of bridge-denture as follows:—*

"Fig. 845 illustrates a case for the supply of a lateral and a bicuspid. In this instance the cuspid could be cut off, and the root collared and capped in combination with a pin entering the enlarged pulp-canal; but, as there may be grounds for objection to cutting off sound teeth, I obviate the necessity by cutting a shoulder on the lingual portion of the cuspid, and suitably shaping its sides to permit a close-fitting collar just under the free margin of the gum. A narrow strip of pure pattern tin, bent tight around the tooth-neck, and cut through with a knife at

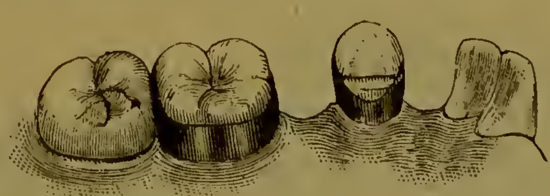


FIG. 845.

the lap on the labial surface, will serve as a measure for the length of a strip of 22-carat gold plate, No. 29 thick, and as wide as the length of the distal side of the cuspid The ends of the gold are then squared, and with round-nosed pliers brought evenly together, to be held in flush contact by the soldering-clamp shown in Fig. 846. The soldered collar, with its joint side inward, is then adjusted on the tooth as accurately as possible, giving slight blows with a mallet until the collar touches the gum, when it should be marked to indicate the necessary trimming to conform it to the gum contour. After it has been

* *Dental Cosmos*, Decem. No., 1886.

thus trimmed, the edges beveled, the labial part swelled with contouring pliers, and the lingual part cut down to about one-tenth of an inch in width, the collar is again driven on, and will appear as seen in Fig. 845. A stump corundum wheel is then used to grind a shoulder on the lingual surface of the tooth, grinding also the edges of the collar flush with the shoulder. The collar is again removed, and a piece of thin platinum plate, about No. 32, sufficient to cover the lingual surface of the tooth, is caught on the lingual edge of the collar by the least bit of solder, and all put in place on the cuspid (see Fig. 847). The platinum should now be burnished on to the shoulder, and over the tooth and collar to the extent shown by the lines in Fig. 847. After trimming to those lines, and careful replacement and burnishing on the tooth, the collar and half cap are removed, filled with wet plaster and sand, and the platinum soldered to the gold. It is then placed on the tooth, burnished into all the inequalities of the tooth, very carefully removed, invested, and enough

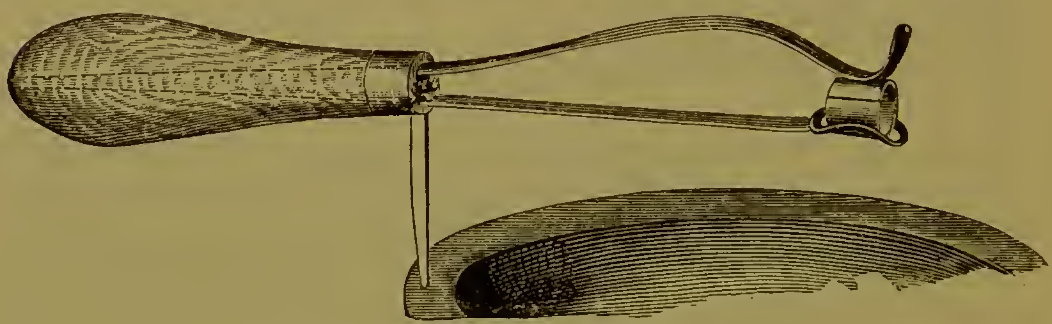


FIG. 846.

solder flowed over the platinum to cover and give it strength. Fig. 848 shows it complete on the cuspid.

"I have feared that a detailed statement would imply a long and tedious process, but I have often made such collars in less than an hour, and in any case time must be made subservient to exactness of fit and adaptation to the end in view.

"In the preparation for fitting a collar on the first molar (Fig. 845), I should have wedged or otherwise separated it from the second molar, so that a piece of sheet brass might be put in place, as shown by Fig. 849, and an impression taken in plaster, which if allowed to get hard would bring away the metal. If not, it could be replaced in the plaster. Melted fusible metal, when near the cooling point, is then poured into the impression, and when cold will allow the safe removal of both the plaster and the metal strip. On this metal model a collar can be formed that will accurately fit the molar, as seen in Fig. 845. If the molar has no antagonist, a cap may at once be struck up on the model, but if there be an antagonist the cusps of

the natural molar should be removed by grinding at points where the occluding tooth will admit of sufficient thickness of the gold cap. An exact copy of the ground cusps can then be made in less than five minutes, by the use of moldine with its accessories, and the process is as follows: Make the tooth perfectly dry. Put the collar on it. Nearly fill the cup (Fig. 851) with moldine, and coat it with soapstone powder. Press the compound on the tooth and collar firmly to


FIG. 847.


FIG. 848.

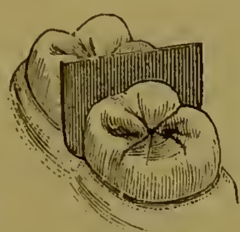


FIG. 849.

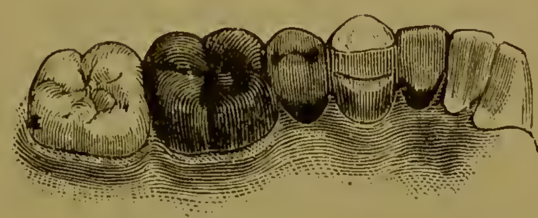


FIG. 850.

about one-fourth the depth of the tooth. Carefully remove the cup; trim off any overhanging material, and place the rubber ring over the cup to about one-half the depth of the ring. Melt the fusible metal and pour it, as cool as it will run from the iron ladle. As soon as the metal is hard, remove it with the ring (Fig. 852), taking care not to impair the impression, which can be used again if the die is found imperfect or gets injured in use. Place the die and ring in cold water, to remain until quite cooled. While the die is wet and held over a basin of water, pour into the ring fusible metal which has been

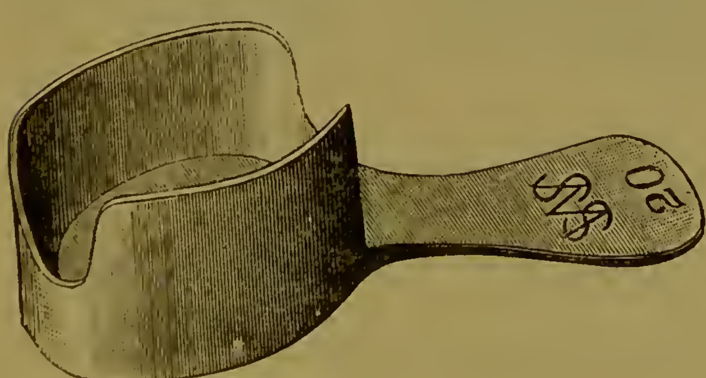


FIG. 851.

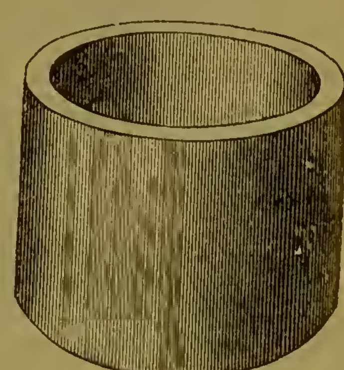


FIG. 852.

stirred until it begins to granulate, and quickly immerse all in the water. The die and counter-die should separate readily by tapping them with a hammer, but if they stick, others can be quickly made from the same impression, by the same method, using more care. With this die and its counter-die, a piece of No. 29 or 30 gold plate is swaged to fit perfectly the cusps and collar, which, when removed, can be held to its place on the cap by the soldering-clamp, using spring pressure enough merely to hold them together for careful

soldering with the pointed flame so as not to unsolder the collar. The seamless collars are excellent when care is used in selecting the proper size, as directed on the diagram.

"The caps being in place on the cuspid and molar, an impression is taken with plaster; the caps accurately set in the impression, and hard wax melted with a hot spatula around the edges of the caps. The impression is then thoroughly coated with sandarac varnish, after which it is dipped for a moment in water, and filled with a wet mixture of one part marble-dust with two parts of plaster; using great care to perfectly fill the caps and molds of the teeth. Wait until this mixture has become quite hard; remove the cup, and with a suitable knife chip off the plaster without marring the cast; secure a good articulating impression, and transfer it to the cast to obtain an exact reproduction of the relative occlusions of all the teeth involved. With such an articulation in hand, and with the means already described for swaging gold or platinum plate to fit the cusps and articulating surfaces of either the natural or artificial teeth, it should be within the capacity of any competent dentist to complete a suitable bridge; although there are practical points that can only be imparted by clinical instruction and actual demonstration in the mouth. Such a bridge is shown in position by Fig. 850."

Dr. R. Walter Starr describes a bridge-denture which can be removed for repair in case of injury, as follows:—*

"It will doubtless be admitted that in some cases bridge-work has advantages over the ordinary plates for partial dentures. It will also be conceded that the security and permanence of the fixture enhances its practical value to the patient so long as all goes well. But if for any reason it shall become necessary to remove the bridge, for repairs or treatment of the roots used as anchorage, its fixedness proves a serious objection.

"In the endeavor to provide a remedy for this defect, the structures now to be described originated, and will, it is hoped, be found applicable in many instances in such cases as are typified by the accompanying illustrations.

"In the construction of such bridges the first thing to be done is to grind with engine-corundums the overhanging edges and sides of the teeth which are to serve as abutments, so that the crown-ends shall be slightly smaller but of the same shape as their necks. This can be demonstrated by bending a piece of fine binding-wire around the tooth-neck, and twisting the free ends together to form a close-fitting loop, which, if the tooth has been suitably shaped, may be

* *Dental Cosmos*, vol. xxviii.

slipped from the tooth without changing the form of the loop, thus giving an exact outline of its form and size. Such a loop is shown in Fig. 853. The loop is then laid upon an anvil, and the squared end of a short piece of wood placed over the wire, and a blow struck to drive the loop into the wood as a guide in shaping the wood to the precise size and form of the inside of the loop, as in Fig. 854. The free end of this wooden mandrel must subsequently be slightly reduced so as to conform exactly to the natural crown. In lieu of this method an exact impression of the tooth may be taken in plaster to serve as a mandrel. About a sixteenth of an inch is then ground from the occluding cusps of the abutment teeth, and an impression taken of the teeth and surrounding parts, to obtain a model, as shown in Fig. 857. A piece of gold plate, say 22-carat fine, number 30 gauge, is cut and fitted closely around the mandrel, and its ends soldered to make a collar, as in Fig. 855. This is laid with the crown end upon a piece of lead, and a piece of wood or metal laid over it and struck with a hammer to drive the collar into the lead so as to hold it securely and maintain its form, while with a smooth, half-round file the neck end is shaped as seen in Fig. 856. The other end of the collar is then cut so that the depth of the collar shall a little exceed the visible length of the tooth, thus allowing the neck end when placed upon the tooth to pass beneath the free edge of the gum. A piece of gold plate, either plain or struck up in cusp form, is then soldered to the crown end of the collar. If a seamless collar is used it can be laid upon the plate for soldering without an investment or a clamping wire. A piece of thin platinum plate, No. 36 gauge, a little wider than the space to be covered with the teeth, is fitted and burnished over the space between the abutment teeth, which have been so trimmed that the caps described will slide on and off easily. These caps are now cemented to the platinum plate, and collars made and fitted to properly fill the space between the abutment teeth. They are held in contact with each other and with the platinum plate

FIG. 853.

FIG. 854.

FIG. 855.

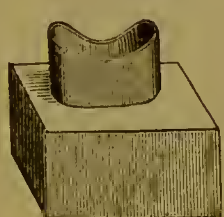


FIG. 856.

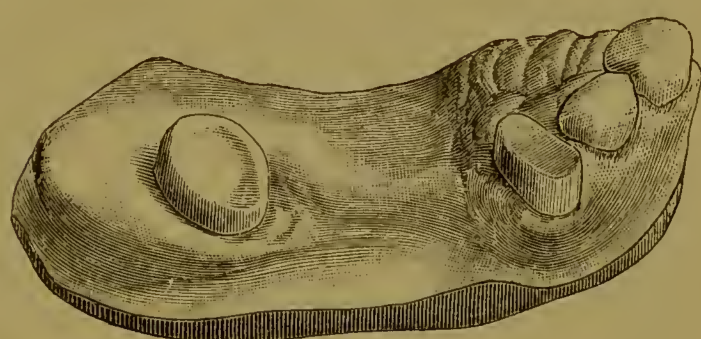


FIG. 857.

by running melted white wax in and between them. The whole piece may then be transferred from the model to the mouth, and stiff mixed plaster and sand pressed into and over the collars and caps. When the plaster has set the mass may be removed, trimmed, and the wax melted away with a result as shown in Fig. 858. The lines of contact of the collars with each other, with the caps, and with the plate are to be neatly soldered, when the investment may be removed, leaving the bridge as shown by Fig. 859. The free edges of the plate may then be trimmed to the margins of the collars or caps, and the whole denture polished. The bridge may now be slipped on and

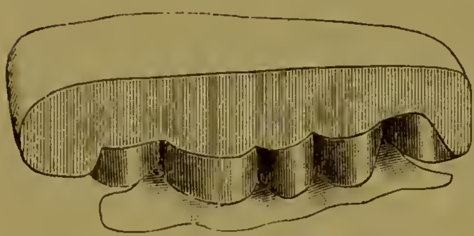


FIG. 858.

FIG. 859.

FIG. 860.

off the natural abutment teeth with just enough of friction to retain the denture in position and yet allow of its ready removal.

"Suitable cusp-crowns (see Fig. 860) are now selected, the cups partly filled with wax, and the cusps placed in position. The denture is then tried in the mouth and the proper occlusion obtained by grinding or filing the edges of the cups. The piece is now to be thoroughly cleansed and dried; the cups nearly filled with insoluble cement, or hot gutta-percha; the cusp crowns set in the cups; the bridge put quickly in place, and the patient directed to firmly and repeatedly close the jaws to properly determine the occlusion. It will be found best to place a piece of paper the thickness of a postal card over the porcelain cusps when forcing the denture to place, so as to insure that they shall be a little short, and thus avoid irritation of the anchorage teeth in mastication. These anchorage teeth or roots will in time elongate and form a close occlusion.

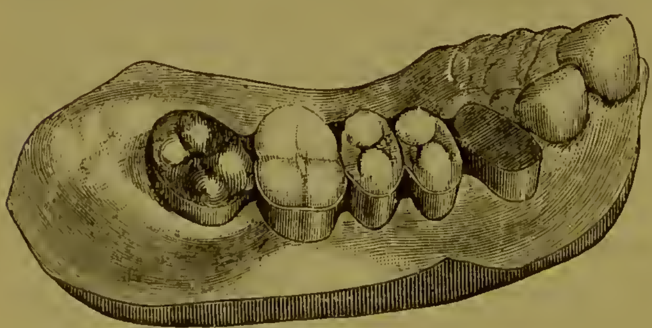


FIG. 861.

"When the cement is properly hardened the piece may be removed. A hole should now be drilled through the metal caps to allow escape of surplus filling material. A small quantity of gutta-percha thoroughly

warmed should now be placed in the caps, and with a piece of card placed between them and the occluding teeth, the caps should be forced home.

"The complete case is represented in Fig. 861.

"The bridge may at any time be removed with warmed forceps beaks held long enough on the caps to soften the gutta-percha. The cusp crowns may be removed, if desired, by the same method and replaced without detaching the bridge.

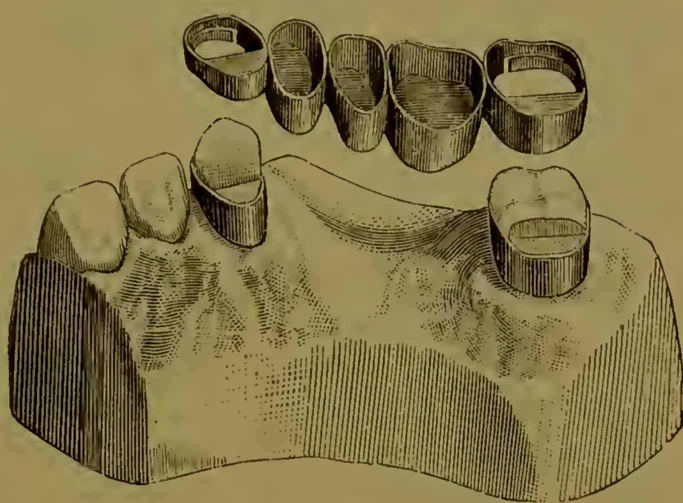


FIG. 862.

"A modified bridge is shown in Fig. 862. It will be observed that collars have been firmly fixed with cement or gutta-percha on the abutment teeth, which have their occluding surfaces ground flat on their inner aspects, so that the partial cap shown may thus prevent the telescoping collars from being forced too far down on the teeth. By means of a frame saw a narrow tongue is cut on the outer face of each telescoping collar, the free portion serving as a spring clasp to hold the bridge securely on the abutment teeth and still allow the removal of the piece whenever so desired. Fig. 863 shows such a bridge in


FIG. 863.

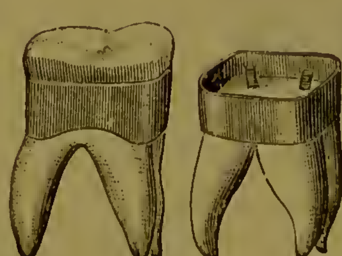


FIG. 864.


FIG. 865.

place. It is obvious that if in this instance the roots only of the cuspid and second molar had been present, they could, by means of the collar and cusp crown devices, have been put in shape to serve as abutment teeth for the telescoping bridge shown in Figs. 862 and 863. The second molar roots so crowned are seen in Fig. 864. When it is desirable to show the faces of the porcelains to a greater degree, the collars may be cut away on the buccal sides and the

countersunk crowns be used as illustrated by Fig. 865. The platinum base may either rest broadly upon the gums or be sloped so that only the buccal border shall touch the gums, or it may be so shaped as to be entirely free from the gum. This is done by building upon the plaster cast, and bending the platinum plate and shaping the gold tubes to the surface so made, depending wholly for support on the abutment teeth or roots.

"Briefly stated, the points of excellence in this bridge are strength, lightness, avoidance of liability to breakage of the porcelain in soldering, ease of construction and adaptation, and the facility with which it may be reorganized, or for any reason be removed and replaced. This last feature is of special value in the not infrequent event of subsequent alveolar abscess, for in cases such as are shown in Fig. 861 the bridge may be removed, the involved teeth drilled, medicaments applied, the bridge replaced, and this process repeated without depriving the patient of the use of the denture."

In the *Dental Cosmos*, Dr. Dexter describes a removable-bridge denture or "cap-plate," as follows:—

"Take a case where, on the lower jaw, there are standing in the mouth a third molar, a canine, and first bicuspid on each side—six teeth in all. These teeth are shortened by breakage and mastication, so that the upper incisors close to within an eighth of an inch of the gum line between the canines; added to this, they are so tipped and twisted in their places as to make it very difficult to properly adapt an ordinary denture to the spaces between them; and, lastly, let the patient evince entire abhorrence of, and a fixed resolution not to permit, the resting or pressure of any appliance upon his gum tissue. Such a case is the one for which I have constructed this cap-plate. Such cases are often treated by building up or down the natural teeth with gold, in order to open the bite, and then replacing lost teeth with an ordinary plate. My apparatus, however, accomplishes both these desiderata in one operation, while simultaneously avoiding any and all pressure upon or irritation of the gum.

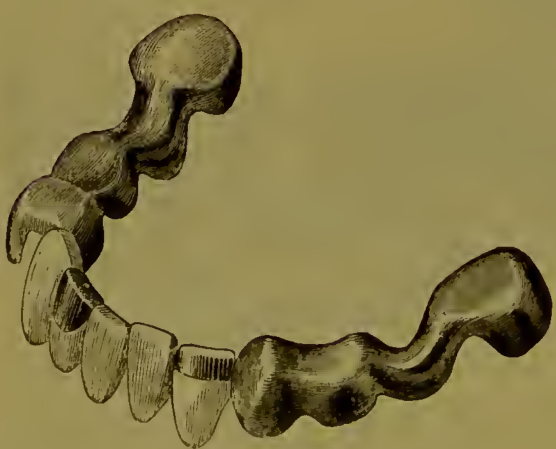


Fig. 866.

"The appliance which I show you (Fig. 866) is constructed as follows: Caps of gold and platinum alloy, of about 26 to 28 U. S. standard gauge, are struck up to fit over and down the sides of the

natural teeth selected for the piers, fitting closely. If all the supporting teeth stand perpendicularly and parallel with each other, thus creating no 'undercut' (so to say), the sides of the caps may encircle the teeth as far as possible (*not*, however, impinging upon the gum-line), and be simply slit (in two or more places on each tooth) perpendicularly, so as to spring apart and allow of sliding the whole over the natural convexities of the teeth, the sides coming together again when in place and thus holding the whole apparatus firmly. But should the teeth be tipped or leaning, and not parallel, the sides of the caps must then extend over only such parts as can be closely fitted and yet be sufficiently perpendicular and parallel to allow of removal and replacing of the appliance. Of such a character is the case now shown you, there being only one place on the six caps where a *slit* is of value; the sides of the caps being so fitted as to hold partly by their own elasticity, and partly by that of the whole apparatus. Such a case, of course, will most severely try the capabilities of any artificial denture; and not the least merit of the present piece is its triumph over, and perfect and *practical* adaptation to, the obstacles of an exceptionally difficult case.

"The caps, when struck up, will not cling to the teeth when in place; nor should they, for they must be capable of easy removal during succeeding processes. But when the piece is ready for final insertion, the sides of the caps must be *sprung inward* sufficiently to hold to their supports with firmness.

"The caps being now made, it is in order to determine the length of 'bite' needed. Place the caps in position in the mouth, and build wax on their grinding surfaces to a proper length and contour, both side and grinding. Invest, remove wax, and flow into its place eighteen-carat gold. Shape the grinding surfaces, by trial in an articulator or the mouth, to the proper occlusion. Next, take an impression with the caps in place, pour the model, select and back plain plate-teeth, and wax them in place. Invest the whole, remove the wax from the backs of the teeth, and fit in the spaces between the caps, bands, or bars of irido-platinum alloy (or gold, as circumstances may determine), being careful that the bars fit *accurately* to the *backings* of the porcelain teeth and to the *caps* at each end. In fitting the bars to the caps, select such points of attachment as will not interfere with the *spring* of the slit sides of the caps. If necessary, let the bars avoid the *sides* of the caps, and reach, by curving, to the *tops* or grinding surfaces. Should you desire to arrange the porcelain teeth irregularly, you need not hesitate to do so. Set them just as you would for rubber or celluloid, and then, simply taking a 'finger impression' of their backs with modeling composition or wax, when

invested as above stated, and making dies, you can readily 'strike up' your bars to fit the irregular positions of the backings. But should this be difficult on account of great irregularity or stiffness of bars, then construct the bars of two or three thicknesses of metal, each struck up separately, and then 'sweated' into one. Next, solder the bars to the backed teeth, but *not* to the caps, as yet. The reason is that *perfect* adaptation of the bars to the caps is absolutely necessary to the success of the piece. Therefore, now place the caps in place in the mouth, and wax the bars with their attached teeth in the spaces between them; filling, grinding, and adjusting until all is exactly as required. Then (and not until then) take an impression of the whole in place, the apparatus coming away with the plaster. Pour the impression with plaster and pumice, sand or asbestos (sand is best), carefully remove the impression plaster, invest outside the model with its sustained apparatus, and then solder the caps and bars together. In doing this as little solder as possible should be used, to prevent warping of the whole. The bars should have a broad, firm hold on the caps; but the contour of their union should be made on the bars *before* they are united to the caps, and *not* by flowing on a body of gold while uniting the bars and caps sufficient to attain the desired hold and shape of union. On the contrary, the bars should be properly shaped at their ends, and carefully fitted to the surfaces to which they will be attached, when a small amount of solder flowed into the joint will make a perfect union and give all the strength possible. This is *not* plumbing work. All that now remains to do is to spring or bend slightly inward, as before directed, the sides of the caps so that they may grasp their supporting teeth firmly, yet not so much as to create difficulty in removal or insertion; then finish and polish. Burnishing is generally objectionable, since it gives, in some lights, a *black shine* to the piece, adding greatly to the prominence of the appliance as a part of the view whenever the wearer opens his mouth.

"Should it be desired to produce the best possible results with the piece, the interstices between the artificial teeth and any other crevices to be found may be filled with gold or amalgam,—I prefer the former; or vulcanite may be packed in such places (which may be, if necessary, cut out to proper dimensions by burring), and finished up smoothly. The piece shown you contains no less than *seventeen* gold fillings, which signifies that no debris, or even moisture, has any foothold of concealment about it, and that it is, therefore, as clean in itself as is possible for any artificial denture to be. This, you will say, is rather expensive work. Very true. The whole method is expensive in both money and labor. But I am quite consoled for this

fact by the thought that it will not, therefore, be likely to do much harm to the public, since the 'cheap-jacks' and 'incompetents' will probably let it alone.

"In the piece shown there are six caps, three on a side. There are five incisor teeth placed between the canines, two of which are capped with gold to break up the uniformity of porcelain in front, as contrasted with the uniformity of gold behind, and thus help to evade artificiality of appearance. Between the molar caps and the double caps for canine and bicuspid, the connecting bar is horizontally placed, dipping downward to parallel the gum line, as well as to evade an encroaching molar above. When necessary, an artificial tooth or teeth can be ground and soldered to these bars. Generally, however, the connecting-bars should be perpendicularly placed, to insure resisting strength in the line of the attacking force."

Dr. R. Walter Starr, in the same journal, describes the following case of removable bridge-denture:—

"The case of Mr. W. presented difficulties of an unusual character, as may be seen by inspecting the illustration, Fig. 867, which renders detailed description unnecessary.

"It will be observed that the molars and the left second bicuspid overhang to a degree that would make the taking of an accurate impression by ordinary methods well-nigh impossible. After a careful study of the case it was decided that two separate pieces of removable bridge-work should be attempted, and, as an essential preliminary step, the overhanging sides of the molars and bicuspids were ground with engine corundum wheels and points until those sides were made much less inclined, when plaster impressions were taken, first of one-half, and then of the other half, of the jaw. Gold cap-

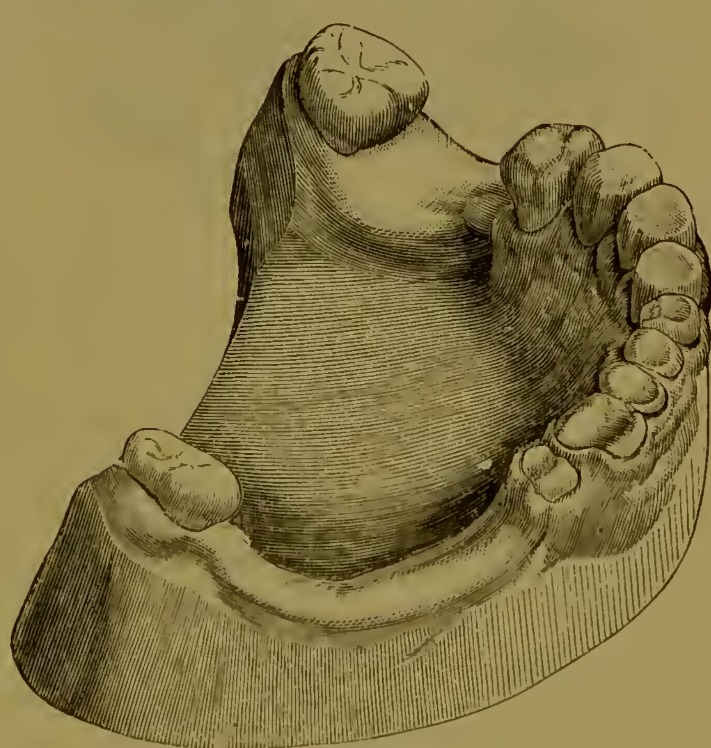


FIG. 867.

crowns were closely fitted over the molars, left second bicuspid, right first bicuspid, and cuspid stump. Gold crowns were made to telescope over all the caps, which were then, by means of oxyphosphate

cement, fixed firmly on the teeth. Suitable plate-teeth were selected, fitted, backed, and hard-waxed in place between the telescoping crowns. After hardening the wax with cold water from a tooth-syringe, the pieces were carefully removed, invested and soldered. The two completed bridges were easily replaced on or removed from the supporting capped teeth, and their appearance when detached is correctly shown by the illustration, Fig. 868, which also shows the capped teeth and stumps. This figure likewise shows the results of the novel method employed in crowning the incisors. Gold collars were fitted tight on the necks of the incisor stumps, and the new-style porcelain caps adjusted in the collars, and set in the oxyphosphate cement which had been packed into the collars; thus at the same time fastening the collars on the stumps and the caps in the collars, as shown completed in Figs. 868 and 869.

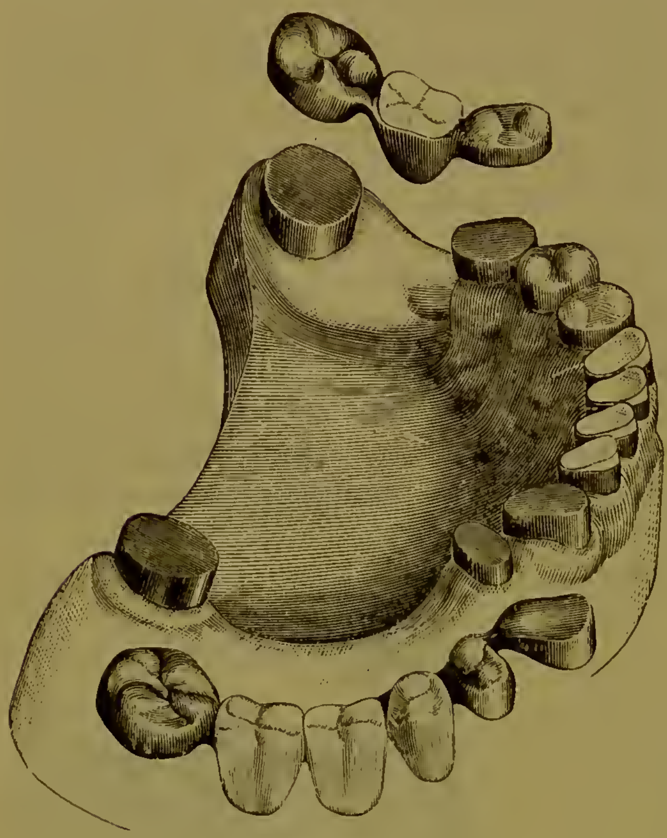


Fig. 868.

"Fig. 869 illustrates the finished crowns and bridges, which latter were secured in position by placing a small piece of gutta-percha in each of the telescoping cap-crowns, which were then warmed and carefully pressed in place—the gutta-percha filling only the spaces between the flat tops of the caps of the natural teeth and cusped caps of the bridges.

"Whenever for repair, or for any other purpose, it shall become desirable to remove one of the bridges, that may readily be done by applying a hot instrument or hot air to the caps, to soften the gutta-percha sufficiently to permit the telescoping bridge to be taken off.

"A full upper vulcanite denture was made to replace the old one, which, by improper occlusion, had thrown the full force of mastication on the anterior teeth of the lower jaw, and produced the destructive action that resulted in the deplorable loss of tooth substance shown in Fig. 867.

"The prosthetic devices thus briefly described have so far proved perfectly satisfactory to both patient and dentist. The obvious difficulties of the case, and the somewhat novel means employed in supplying useful and secure dental substitutes, seem to justify the writer in bringing the case to the attention of the profession."

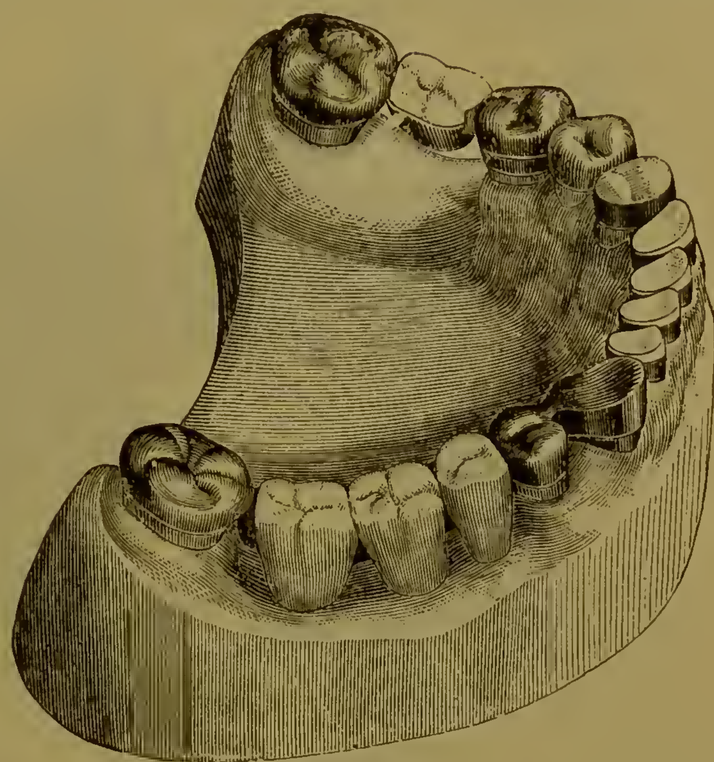


Fig. 869.

A bridge of this form can also be made removable by cementing it on the natural crowns or roots with gutta-percha, and by still further securing it by screws entering the body of the crowns or roots through the gold forming the occluding or grinding surface portion.

Dr. H. C. Register has devised the following method, which, in the event of a porcelain crown being broken, possesses the advantage of allowing the place to be filled by a new crown without disturbing the main appliance. The following concise description of this method is by Dr. Dexter:—

"Taking a typical case (Fig. 870), a rim or saddle of gold, platinum, or iridinized platinum is struck to fit the spaces between the teeth A and B. To this are attached bars, X, Fig. 872, to enter the fillings at Z, Z (Fig. 871). Posts or pivots (D, Fig. 872) are soldered upon this saddle where the artificial teeth are to be placed, their free ends being threaded to carry the nut E. Hollow crowns, countersunk for the nut at G, and having the necks ground to reach over the saddle and press upon the gum, are fitted over each post. Amalgam is used to fill in the space between the post and the tooth-wall, as in a Bonwill setting, and the crowns are drawn to place and held with the nut. The saddle is fixed in its place in the mouth, before the crowns are finally attached, by filling into the cavities Z the bars X X."

Dr. J. L. Williams suggests the following methods for the single crown and for "bridge-work," which he describes as follows:—

"It consists essentially of three parts: a square pin of platinum

and iridium which enters the enlarged pulp-canal, a cap of gold, and the porcelain face, which is the ordinary plate tooth.

"This crown is made in the following manner: After the end of

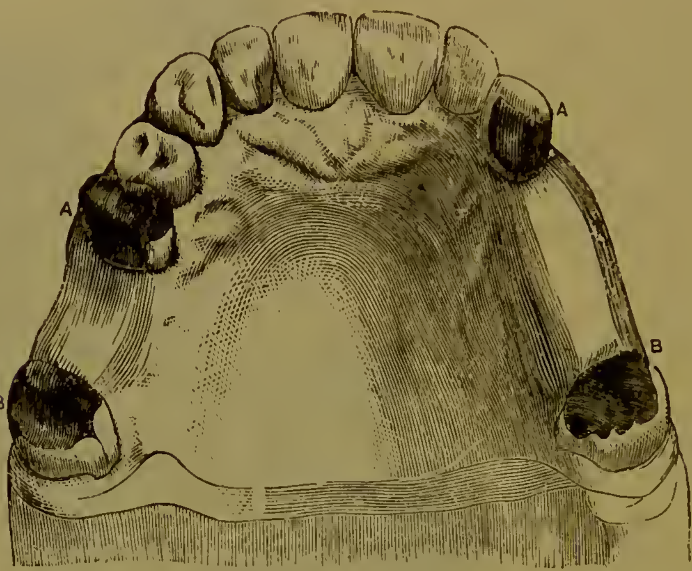


FIG. 870.

the root is made perfectly smooth with corundum wheels and properly shaped scalers, a gold ferrule or band is fitted around it. If it is desirable that this band should be entirely concealed, the labial surface of the root should be beveled a little above the margin of the

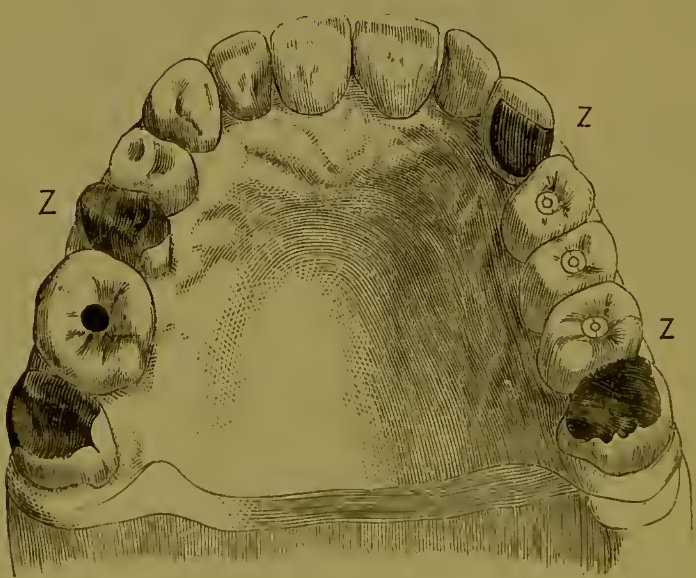


FIG. 871.

FIG. 872.

gum, and after the band has been soldered it may be placed in position, and the line of contour of the margin of the gum marked upon the front of the band. The proper bevel can then be cut and the

edges squared upon a corundum wheel, leaving the lingual portion of the band a little longer than the front. Pure gold, rolled to No. 34 of the standard gauge (American), is used for soldering upon the beveled surfaces, thus making a closed cap for the end of the root. A suitable tooth is now selected and backed with pure platinum or pure gold. The cervical end of the tooth is then ground to the proper position on the front bevel of the cap, all of the fitting being done while the cap is in position on the root.

Fig. 873.

"After the fitting is completed the cap is removed and the tooth attached by strong resin wax and again placed in position while the wax is warm. Any slight change in position which is necessary can then be easily made. The tooth and cap are now removed together, invested, and united at the back by solder. It is well to use a solder for the cap with a higher melting point than that used for the backing, as it obviates the danger of unsoldering the band when the backing is flowed on. After finishing and polishing the work, the end of the root is made perfectly dry, a sufficient quantity of oxyphosphate cement, mixed somewhat thinner than for filling purposes, is placed in the enlarged pulp canal and also in the cap. The crown is then carried to place with firm, steady pressure, held a few minutes until the cement is sufficiently hard to prevent displacement. The surplus cement which has oozed out around the band should be carefully removed, and the work is then completed."

Dr. Williams's method can be applied to "bridge-work," as the following Figs. 874, 875, and 876 will show.

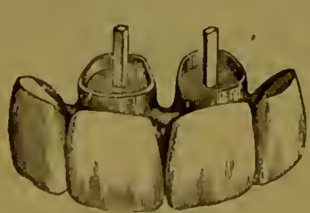


Fig. 874.

Fig. 875.

In this method, special crowns, Figs. 877 and 878, for molars and bicuspids, with porcelain faces, are made, which are backed with gold or platinum and the tips ground squarely off. Zinc pattern dies are made from the grinding surfaces of molars and bicuspids,

to be used for swaging from pure gold a tip or cap for the protection of the porcelain face. The concave surface of these tips is filled by melting coin gold into them, and this surface is then ground smooth and fitted to the squared surface of the porcelain face and waxed into position. Triangular pieces of platinum are then cut of the proper size to fit the sides of the tooth, waxed in position,

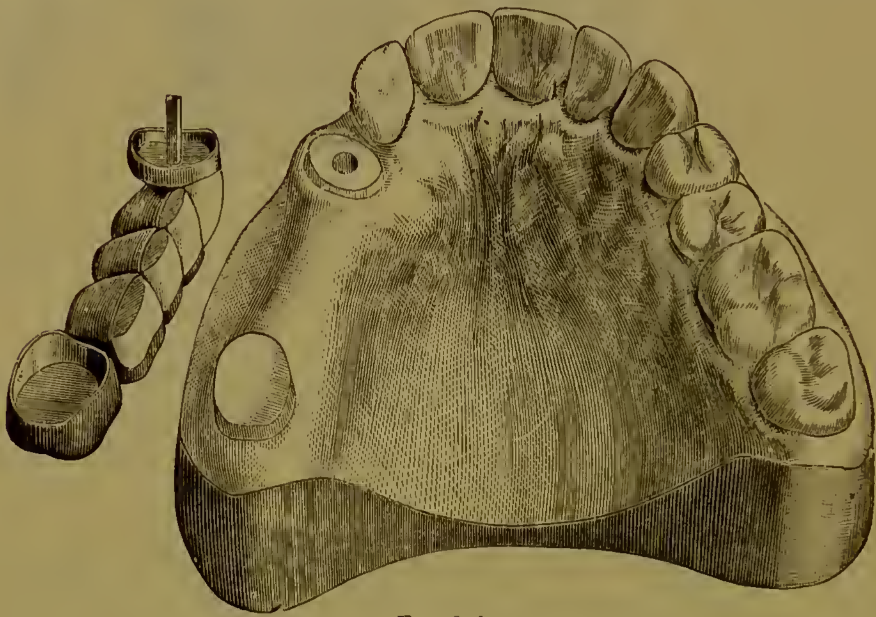


FIG. 876.

FIG. 877.

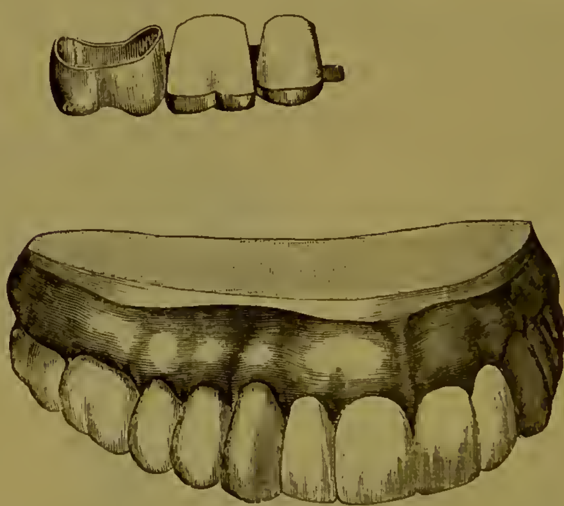


FIG. 878.

and the whole invested, leaving the back open, which is filled with coin gold.

Dr. Williams also describes other forms of bridge-denture, in one of which there are no supporting roots, and in the other the sections are united by bands of gold.*

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* *Dental Cosmos*, December, 1885.

"Figs. 879 and 880 illustrate a method of inserting extensive pieces of bridge-work in cases where there are no natural teeth or roots for supporting one end of the bridge. The work from which these drawings were made was constructed by Dr. H. A. Parr. By this method bridges may be inserted in cases where all of the teeth on one side of the mouth have been lost, or where all the teeth anterior to the molars on both sides are wanting. Crowns are first fitted to the teeth which remain. These crowns being in position, an impression is taken. From this a cast is obtained with the crowns in their proper positions. A second impression is also taken of that portion of the mouth where there is no natural support for the bridge. From this impression metallic dies and counter-dies are obtained, from which is 'struck' a small gold plate about three-fourths of an inch in length and width, the size of the plate varying according to position and other conditions. After this little plate or 'saddle' has been perfectly fitted, it is waxed in the proper position on the model, with the crowns. The intervening teeth are now placed in position, and the work invested and soldered. To provide for the possibility of shrinkage or absorption at the point where the plate or saddle rests, it is suggested that it be not soldered to the bridge, but attached by means of an adjustable screw.

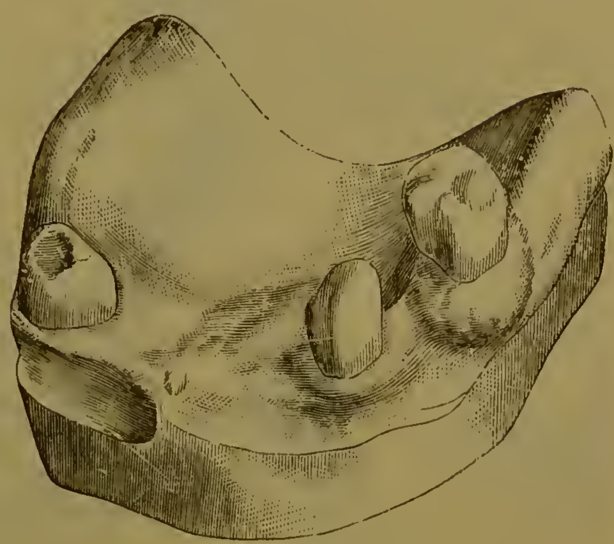


FIG. 879.

FIG. 880.

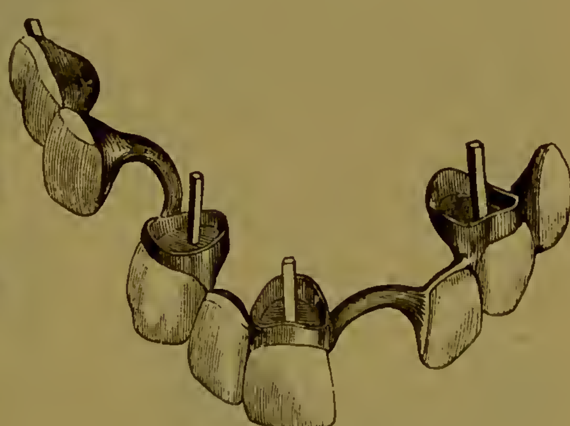


FIG. 881.

"Fig. 881 illustrates another device for obviating the necessity for

removing the crowns of natural teeth in preparing the mouth for bridge-work. Crowns are fitted in the mouth to the points of attachment in the usual manner. An impression is taken, bringing the crowns away in their proper positions. From this the cast or model is obtained. Heavy bands of half-round gold or platinum bars are now fitted around the necks of the natural teeth, on their lingual surfaces. These bands, being waxed in position, serve to connect the different parts of the bridge, uniting them in one piece without the loss of any of the natural crowns. I have found this a highly satisfactory method of inserting extensive pieces of the work. Fig. 882 shows the mouth as presented, for which the piece shown in Fig. 881 was constructed. Fig. 883 shows the piece in position.

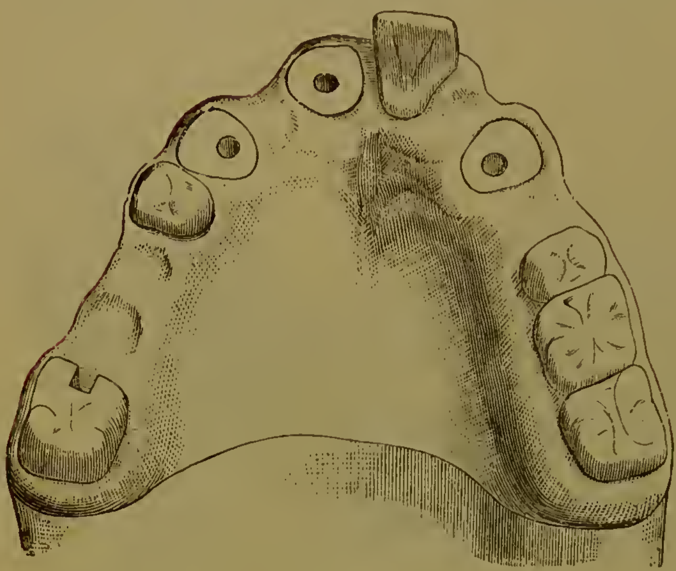


FIG 882.

"Fig. 884 illustrates a case which is a type of a class of frequent occurrence. Alternate molars and bicuspids in the upper and lower jaws are lost until the occlusion is somewhat changed, and the force of mastication is gradually brought upon the front teeth. Rapid wearing of these teeth results. These cases are among the most difficult that the operator is called upon to treat by the ordinary methods. In the case herewith illustrated, the lower bicuspids with a molar on one side were in good condition, but the loss of the upper bicuspids and molars made them useless. As usually happens, the upper incisors had suffered most. The lower incisors were restored by capping them with cohesive foil. The bridge shown at Fig. 885 was constructed for the right side of the upper jaw, while the teeth on the left side were restored by contour work, as shown at Fig. 886.

FIG. 883.

"The superiority of the condition of this patient's mouth, which resulted from this work, over anything which could have been accomplished by plate work, is almost inconceivable to one not familiar with these methods.

"The only annoyance which bridge-work is likely to cause patient or operator is the occasional breaking of a porcelain, an accident of

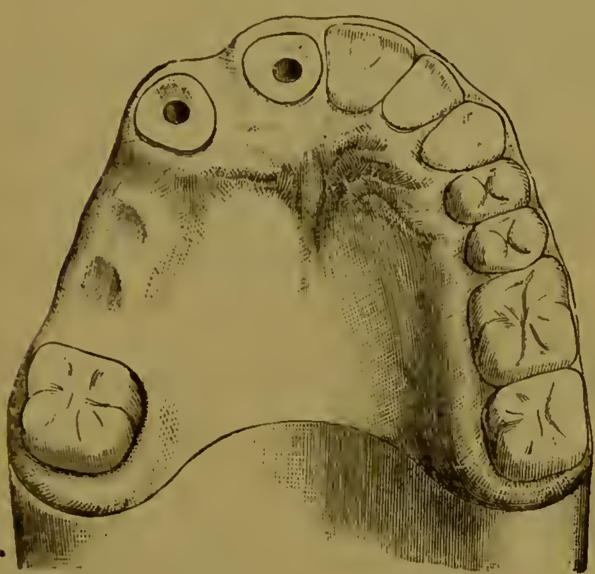


FIG. 884.

FIG. 885.

not frequent occurrence. While the replacing of a broken porcelain has never been a matter of extreme difficulty, yet I have always regarded the methods hitherto employed as more or less imperfect and uncertain in their results. This led me to devise a method of replacing broken porcelains which leaves the work fully as strong as before; a method which makes the operation a very simple one, requiring less

FIG. 886.

FIG. 887.

than an hour for its performance; and after the porcelain has been replaced, an expert would not discover any traces of an accident. After removing all traces of the broken porcelain, the projecting pins are cut off, and two holes drilled through the backing in the exact position occupied by the pins. The narrow space of metal now in-

tervening between these two holes is cut out with a fissure-bur. This leaves a groove which should not be wider than the diameter of the pins. The length of this groove should now be increased on the lingual surface, but not on the front. The object of this is to give a dove-tail shape to the groove, which is easily effected by the use of the same fissure-bur above referred to. The lingual appearance of this groove when properly shaped is shown in Fig. 887. The proper tooth is selected, the pin passed through this hole and bent outward into the dove-tail groove. It now remains but to fill the space between the pins with any form of cohesive gold (I use crystal gold), and with corundum, Arkansas, and rubber points in the engine the surface is finished and polished. The wedge-shaped filling of crystal gold acts as a keystone between the pins, and makes a most perfect method of repair."

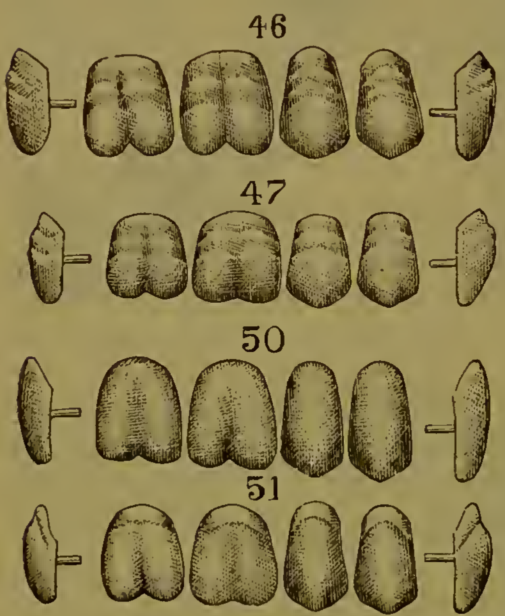


FIG. 888.

Porcelain veneers or facings for bridge-work are represented by Fig. 888.

These facings of molar and bicuspid forms have two long platinum pins (cross-wise) for attachment. They are specially designed for use in bridge-work operations. The long pins afford facility of repair when a tooth has been broken in use. Incisor facings of the same character are also employed.

Dr. H.W. Howe recommends the following flux that is exceedingly useful in bridge-work and is prepared as follows. Put in a cup:—

Boracic acid,	1 oz.
Ammonia,	½ oz.
Carbonate of ammonia,	½ dwt.
Bicarbonate of soda,	2 dwt.
Water,	4 ozs.

Boil until the fumes of ammonia are no longer given off. Coat the bridge or other work all over the gold with the flux. Heat it over a spirit-lamp to dry it on. Give it another coat, if needed, leaving no part exposed. Then scrape off where it is desired that the solder shall flow, and it will go nowhere else. The work will come out of the heating as bright as when it went in, and the solder will be smooth. The polished surfaces will not be corroded or blackened.

Dr. A. S. Condit has devised a combination of plate- and bridge-work, and describes his method as follows:—*

"How well do bridge-workmen know the difficulties incurred in preparing a case for a piece of bridge-work when the teeth on each side of the case converge or diverge! My object in devising the new method was to avoid the above mentioned difficulties. It is sometimes almost necessary to expose the pulp, to make the sides parallel. By the new method it is only necessary to dress the tooth until the band or crown can be nicely adjusted, the same as would be done to nicely cap the tooth for its preservation.

"The attachment tubes or sockets are placed upon the bands or crowns parallel to each other, regardless of the position the teeth may occupy in the arch.

"Fig. 889 represents a case where all the teeth posterior to the cuspid on the right side of a lower jaw are lost, a case which could not be retained by a clasp, and the only method known to the profession is to couple the teeth on both sides with a plate, permitting all the pressure of mastication to come on the gums and alveolar process, causing continued absorption and the usual tilting of one side while biting upon the opposite side. In following the new method a band or crown is first made for the tooth adjacent to the space to be filled, then a tube or socket is made of gold or any suitable metal and soldered to the band or crown on the side next to the space on a line parallel to the lingual side of the tooth. The length of the tube is governed by the amount of space between the tooth so attached and the tooth in the opposite jaw. The longer the tube the better, yet when two attachments can be made the tube can be very short, for the solidity of the work depends almost entirely upon the lock-pin. By this method no undue pressure is placed upon the gums, as the resistance in mastication is partly taken up by the tooth or teeth to which attachment is made. The tube or socket referred to, which, as previously mentioned, is soldered to the band or crown, has placed on the lower end an annular flange, making the opening at the lower end of the tube a trifle smaller than at the upper end. To this tube is fitted what is termed the cap and shield. The shield part is also a tube just large enough to fit over the one fastened to the band or crown and encircle it except at the side which is soldered. The cap covers the upper end of the large tube or shield and has a thread-hole through the center into which is screwed the lock-pin. The lower end of the lock-pin is split and surrounded by an annular groove which corresponds with flange in tube upon band or crown, so that when lock-pin passes into the tube it is compressed

* *Ohio Dental Journal.*

by the flange until it reaches the groove upon the pin when the spreading out of the pin locks it firmly in place and it cannot be detached

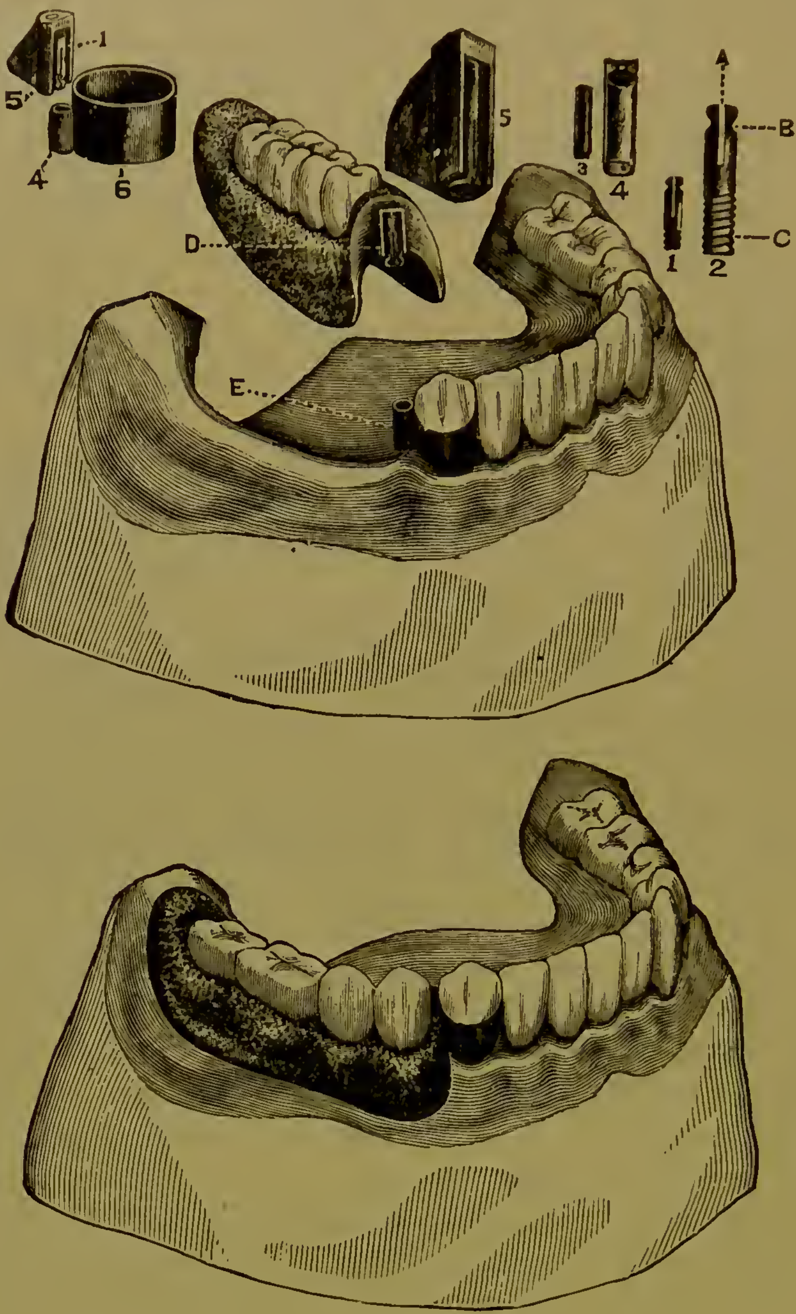


FIG. 889.

In upper portion of above illustration is represented the device in sections, viz:

1 represents the exact size of split pin.

2, the same magnified, of which A represents the split.

B, the annular groove, and C the screw.

3, the exact size of the tube or socket.

4, a magnified view of same.

5, shows the different parts of device put together.

6, illustrates a band with tube 4 attached.

D, represents the device placed in the work, and E the tube or band ready for adjustment.

except by a straight up or down pull. The cap and shield also has a projecting ear, the purpose of which is to firmly hold it to the plate.

"Fig. 890 represents a case attached to central incisor and second molar on the right side of lower jaw. This is a case which would be considered impracticable for any other kind of work and right here

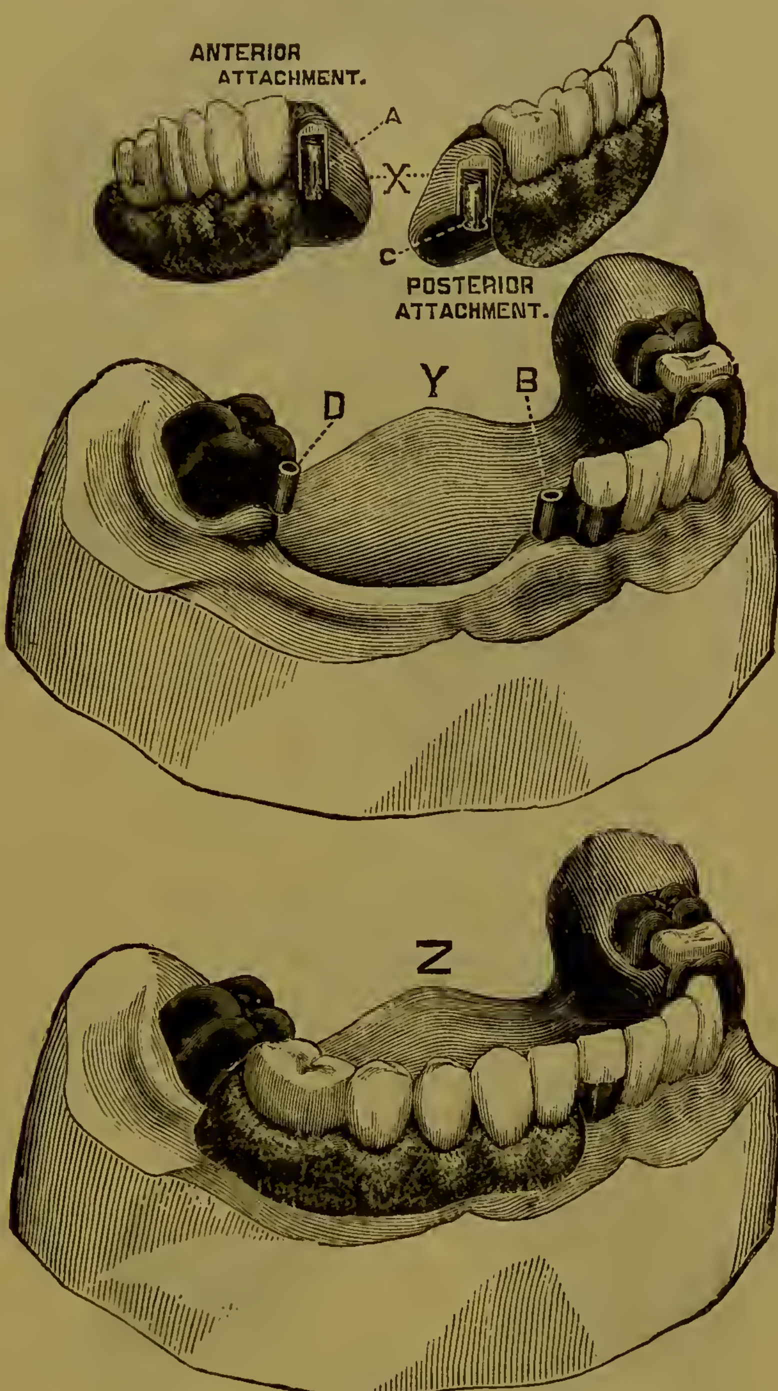
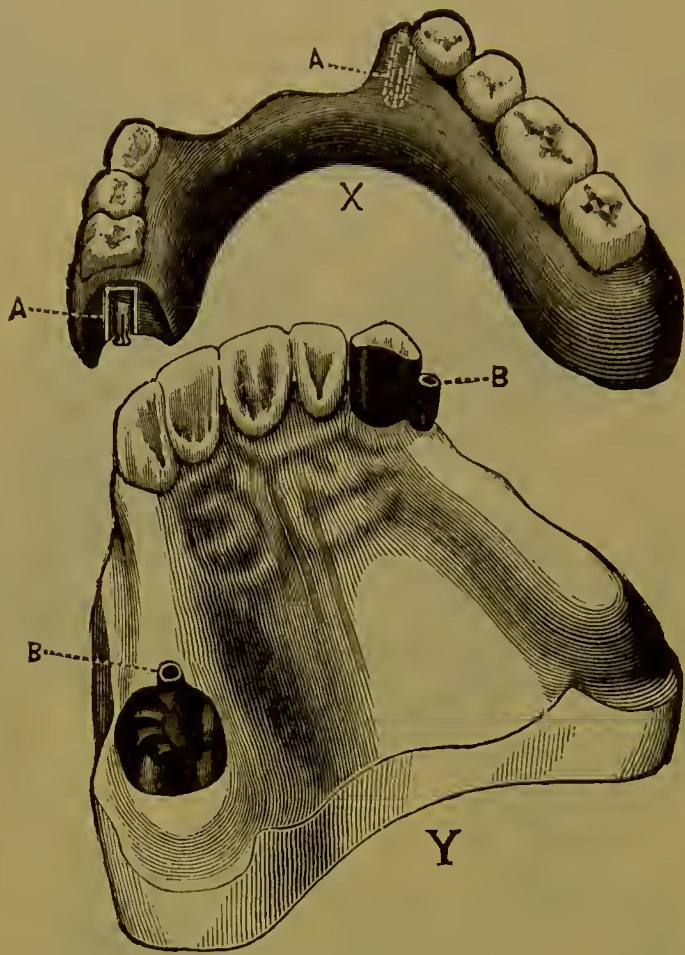


Fig. 890.

In Figs. 890 to 894, X represents the work ready for adjustment. Y casts of the mouth with bands and crowns in position and tubes in proper place for the insertion of the work. Z the work in position on the cast. A represents the device as placed in the work. B the tube placed on band. C the split pin in position in the device, and D the tube as placed on crown.

it might be said that it was the difficulties presented by this case of making anything satisfactory or permanent by any former method,

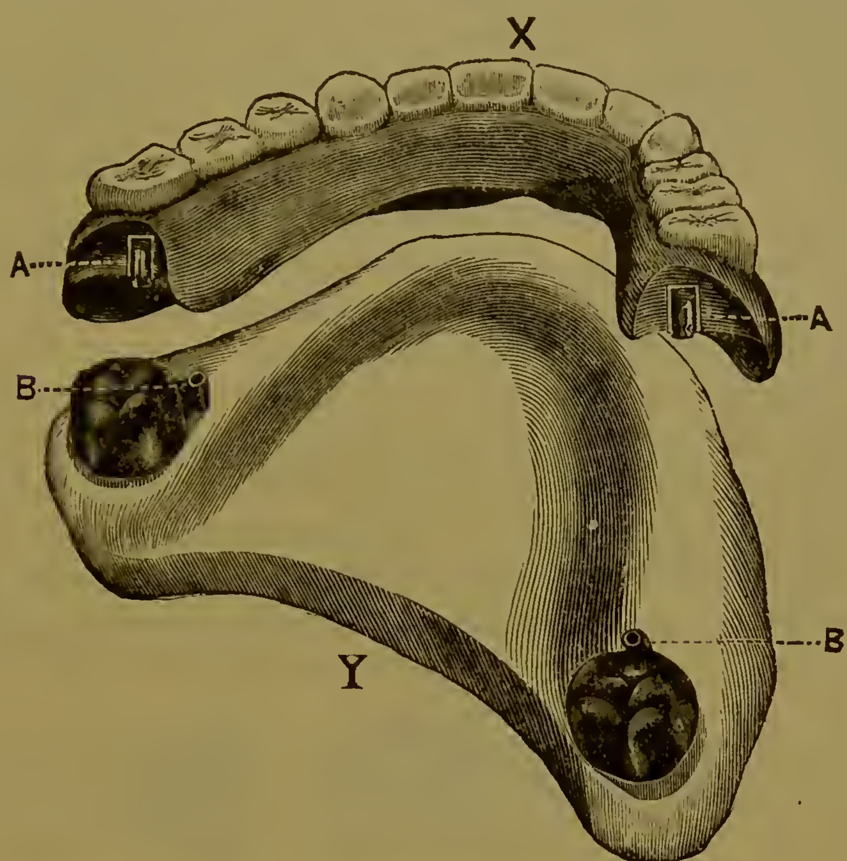


Showing mode of attachment.

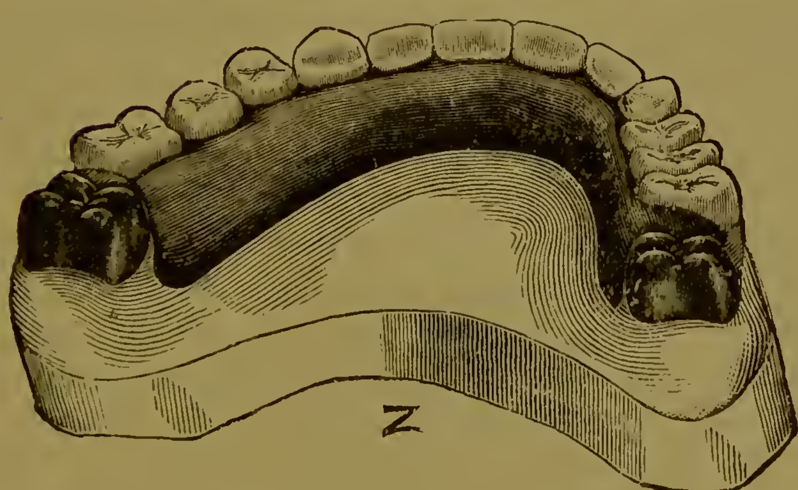
Showing bridge-plate in position.

Figs. 891, 892.

that caused the devising of "The New Method." On the left side of the jaw was a piece of bridge-work which forbade any attachment of plate to that side and it was certainly not advisable to use the incisor as one of the piers for a piece of bridge-work, for it would soon be



Showing mode of attachment.



Showing plate in position.
FIGS. 893, 894.

moved from position and lose its efficiency if suspended from the gum; nor was there any more encouragement of retaining the plate by clasping one or both teeth. It was quite a puzzle to know just what was the best thing to do. It was certain if satisfaction was attained some-

thing new must be adopted and the solving of the problem brought to life 'The New Method.'

"Figs. 891, 892 represent the upper jaw of the case above cited. With molars and bicuspids gone on the left side, the cuspids and bicuspids gone on the right, in this case we find it necessary to connect the teeth on both sides, that the strain occasioned by the weight on cuspid may be relieved somewhat by the molar. No one rule can be applicable in all cases, but the general principles are so familiar that they need no description and with slight modifications they may apply in most cases. In this case an attachment was made to cuspid and molar, connecting the two by a narrow strip of plate, thus avoiding the covering of the entire palate, and when the work was in place it was equally as strong for mastication as bridge-work could be.

"Figs. 893, 894 represent an upper case with only the second molars remaining. The attachments are sufficiently secured for comfort in masticating with but very little if any strain upon the natural teeth.

"One of the strong features of this method and one that cannot be attained by any other class of work in cases of absorption of the gums and alveolar process, which is not apt to occur as there is no undue pressure, is that the tube and lock-pin can be shortened and the plate brought as close to the gum as desired."

Dr. George Evans describes his method of forming hollow gold molar and bicuspid dummies for bridge-work, and also of making collar or ferrule crowns, in which no gold is exposed at the cervico-labial portion, as follows: * —

"Practical experience in bridge-work evidences the advantages of all-gold bicuspid and molar dummies in cases which properly admit of their use; but where they are long or large, the weight and expense, owing to the amount of gold required to fill them, are at times objections to their use. To overcome these objections and lessen the labor of construction, he had lately devised a method of making all-gold dummies hollow, as follows: Take a contour gold crown of suitable size, with a thick grinding-surface, or one which has been thickened with solder and the flux removed, and cut away the gold forming the palatal section of the collar to the form termed self-cleansing, or shape the neck of the crown to the exact contour of the portion of the gum the dummy is to rest on, and scrape a little from the surface of the model to cause pressure and insure closeness of fit. Melt a small quantity of solder with flux to a ball form. Fit a piece of platinum plate, about No. 32 gauge, over the aperture; place the ball of solder on the platinum within the gold cap (see Fig. 895).

* *Dental Cosmos.*

Hold cap and platinum in a Bunsen flame, and heat slowly until the solder melts and appears under the edge of the cap, then instantly remove from the flame, trim the platinum, and stone the edges. This gives you a hermetically inclosed dummy-tooth of gold, from the interior of which the air has been exhausted by the heat. The dummy can then be placed in its position on the bridge and soldered in the usual manner. Fig. 896 gives the palatal aspect of a bridge the dummies of which were constructed in the manner described. The bicuspid dummy is given a self-cleansing form, and the molar is shaped to rest on the gum.

"The advantage of a collar or ferrule on crowns for the front teeth as affording additional security of attachment and insuring against all possibility of longitudinal fracture of the root, is generally accepted.

"The objectionable features of collar crowns are the exposure of the collar at the cervico-labial section, which is difficult to avoid, and the irritation its presence there is apt to cause the peridental membranes, which it is more liable to do at this point than at the other sides of the root. The collar, to be invisible, has to be fitted well under the gum-margin. This requires extensive removal of the periphery of

FIG. 895.

FIG. 896.

the cervico-labial section of the end of the root, rendering adaptation of the collar at this point an operation few practitioners succeed in accomplishing perfectly. An examination of collar crowns in the mouths of patients frequently results in showing a condition, as regards construction and adaptation, such as is shown in Fig. 897, at either of the points A or B, or both. At A, the edge of the collar, owing to the inward slant of the root, protrudes slightly, and at B the porcelain is projected beyond the line of the collar for position or to hide the metal. Either or both in time produce and maintain an unclean condition, worse than a deep-seated line of cervical decay in a natural crown, causing irritation and gradual absorption of the adjacent investing membranes.

"The form of crown about to be presented is not new in principle, neither is it offered as a universal substitute for the ordinary collar crown, but as embodying features which are advantageous, and without some of those found objectionable in the ordinarily used collar crowns. The method will greatly simplify and facilitate the operation, and it is one which can be accomplished by those of only ordinary skill.

"Take, for example, the right superior incisor illustrated in Fig. 898. A shows the line of trimmed root; B, point at cervico-labial section which may be removed if it is desirable to have only the porcelain front cover that part. In Fig. 899 an enlarged outline of the surface of the prepared end of the root is presented, A being the

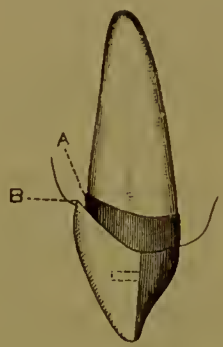


Fig. 897.

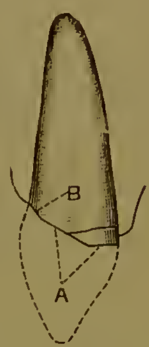


Fig. 898.

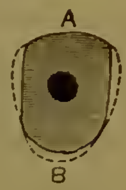


Fig. 899.

labial and B the palatal side. The dotted line is intended to indicate the original form. The shaping is done in the usual manner with discs and trimmers. It will be seen that the line of the labial portion is left intact.

"The root-canal is next enlarged with an Ottolengui root-canal reamer (see Fig. 900).

"The size and condition of the root and the judgment of the operator should determine the number or size of reamer to be used and the depth to which the canal should be reamed. To the reamed canal is fitted a prepared iridio-platinum post, as illustrated in Fig. 901, cor-

Fig. 900.

Fig. 901.

Fig. 902.

Fig. 903.

Fig. 904.

responding in size by number to the reamer used. These posts have a screw-thread cut on the sides, tapering downward to the point, so that they can be screwed just where wanted and soldered in an instant. Next take a prepared disc of platinum plate, having a perforated concave depression as seen in Fig. 902. This depression fits in the orifice of the root canal. If necessary, the orifice may be slightly enlarged with a round-headed bur. This disc of platinum plate, which is about No. 35 gauge, is made by stamping with a punch or

die. In the depression in the disc, as shown in section in Fig. 903, pure gold with a little flux is melted, and in the center of this gold a hole is punched through the disc. The post when fitted to the canal is grasped at the line of the orifice of the canal with small pliers, the post removed, and without moving the position of the pliers it is screwed into the disc up to the points of the pliers, thus giving the post its position in the disc. The sides of the disc are bent on account of the approximal teeth, as shown in Fig. 904, and the relative positions of the post and disc on the root are determined.

"The disc should fit in the orifice of the canal when the post is in position. By twisting the post in the disc, change of position is instantly effected. Both post and disc are next removed, and the post secured in position in the disc by being held in a Bunsen flame, and heated to a point that fuses the pure gold in the depression. No flux is necessary, as sufficient remains from the first fusing of the gold. The post with the disc is next inserted on the root, the platinum pressed with a large flat plugger, and malleted so that the line of the edge of the end of the root will be impressed upon it. The platinum is next removed, and slit at the two points between the palatal and approximal sides shown at A and B, Fig. 905, and guided by the mark of the end of the root on the platinum the approximal portions are bent over with small-pointed pliers to embrace the sides of the root. The post and cap are then placed on the root, and the side flaps, with the aid of foot-shaped condensers and burnishers, are closely fitted. The palatal flap is next brought down to position. Frequent removals and annealings are necessary during the process, which should include finally trimming the edge of the platinum, smoothing with a corundum point, and then annealing and all-around burnishing of the cap to the root.

"At the cervico-labial section the porcelain can rest on the platinum, or the platinum can be trimmed so that the front edge of the porcelain may be fitted against the root, covering it (see Fig. 905). The projecting end of the post should also be removed, leaving it a little flush at the palatal side. The porcelain front, which should be a cross-pin plate tooth, is ground and closely fitted to the surface of the root or metal, as may be, at the cervico-labial section under the edge of the gum, but a properly shaped space opening toward the palatal side is left between it and the surface of the cap. To so shape the porcelain simplifies the fitting of the cervical section. The space between the cap and the porcelain is also easier filled in the soldering. To the porcelain front at the part B (Fig. 906) a piece of very thin platinum foil is shaped, the porcelain heated, the part veneered with a mere film of gum-shellac, and by pressure with a napkin or cotton the

platinum foil is attached thereto. The rest of the porcelain is then backed with thin platinum plate (about No. 35 gauge). The platinum is left slightly extending over the incisor edge, and the porcelain front is waxed in position on the cap.

"Fig. 907 shows the crown waxed up ready for investment. Wax in full amount must be extended over the collar to its edge, in the seams, and between the porcelain and the cap at every point solder is to flow. (Dr. Evans generally uses Parr's fluxed wax.) Fig. 908 shows the invested crown with the wax removed. In trimming the investment, the material must not be removed from over the collar lower than the line of the surface of the cap, or in such a manner that the platinum turn-over edges are exposed to the direct force of the flame. If the collar is not exposed, the solder will flow over the outer surface of the platinum just where it is wanted and where wax has been applied, and all the parts will become united.

"The investment must be slightly raised at one end, and heated up at its base with the full flame of a gas blowpipe thrown in the direc-

FIG. 905.

FIG. 906.

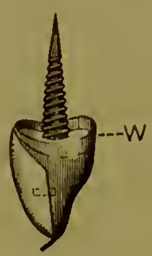


FIG. 907.

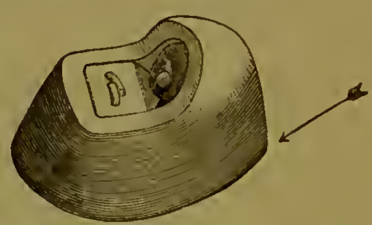


FIG. 908.

tion indicated by the arrow in Fig. 908. Heat thus applied will cause the solder to flow downward and fill the interstices in all parts of the investment as though it were an ingot. The best way is to apply a little solder at a time until the deep parts are filled. The flame is then withdrawn for an instant, and with a small pointed flame and more solder the backing can be contoured. As platinum forms the cap and backing, the soldering can be conducted without fear of accidentally fusing those parts.

"The form of crown described, as well as the ordinary collar crown, he usually cements in the following manner: Having the root and crown ready, he warms the crown and applies a thin coating of chloro-gutta-percha to the post. The chloroform, instantly evaporating, leaves a film of heated gutta-percha. Immediately the crown is adjusted to the root and removed. This shapes the gutta percha on the post. The crown is then allowed to cool, and is cemented on as though no gutta-percha was used on post. A crown so cemented can be removed at any time by repeated applications of the thick part

of a heated root-canal drier to the metallic portion of the crown, which communicates the heat to the post. In a short time the sheath of gutta-percha around the post is softened, and the crown can usually be removed without difficulty. He also attaches ordinary bridge-work in this way, having abandoned the use of methods classed as 'detachable,' which only allow the bridge to be removed by the dentist.

"Porcelain can be used in the construction of the crown described instead of gold solder. In such a case, the porcelain front should be attached to the end of the post. This can be done by flattening the end of the post and riveting the pins, or by soldering them.

"Fig. 909 represents a removable pin crown. It consists of a crown having a threaded socket, I, to which is fitted a correspondingly threaded silver pin, II, which admits of freedom in grinding and fitting the crown to the root without the interference of the stationary pin.

"Another crown, known as the Downie Crown, is designed to obtain a perfect adaptation to the root by means of a platinum band or cap, which not only prevents the splitting of the root, but protects the joint from decay and the washing out of the cement, and materially

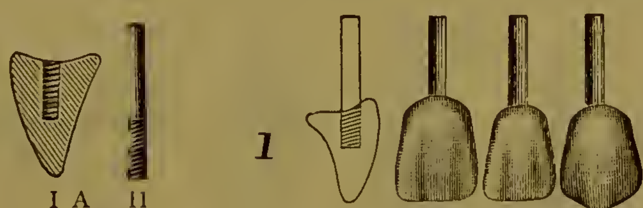


FIG. 909.

strengthens the attachment of the crown; the anterior portion of the band is covered with porcelain of the same color as the facing, so there is no metal showing whatever, and no necessity of cutting the root off far above the gingival margin and lacerating the gums; it is made with the teeth used for other work, so that no special tooth is required; the backing is fused on to the facing, making a perfect union, so we do not need any metal to protect the point to keep the facing from being broken off; the laborious work of grinding away the back of the tooth, and the always unsatisfactory guesswork in setting the facing, which are necessary in some other porcelain processes, are entirely obviated.

"Fig. 910 represents the Downie Crown, the directions for constructing it by the use of the Downie Porcelain Crown Furnace, represented by Fig. 912, being given as follows:—

"Dress up the root even with the gums, and prepare it in the usual manner for crowning. Take measure with small wire, cut the wire on the opposite side from the twist, and straighten it out. Take a strip of platinum, about 30 gauge, of sufficient width for the band, lay

the wire on the platinum and mark the length. Cut $\frac{1}{32}$ of an inch longer than the mark, bevel both ends, lap to the mark, and solder together with pure gold. In this case, as in all others in porcelain work, the soldering should be done with as small an amount of gold as possible, and then the joint dressed off so that there is no gold left showing. Fit the band to the root, letting it extend nicely under the free margin of the gums. If the band is now nearly even with the root, grind it off flush. If it extends much beyond the surface of the root, it should be marked and removed to be clipped off, then replaced and ground perfectly even. It is again removed, and a piece of platinum fitted and soldered over the top, using pure gold as a solder. The overhanging edge of the top is now clipped off and filled up, and the sharp edge of the cap dressed off, also the edge of the band. The cap is now completed as shown in Fig. 910, 1, except that it has now to be placed in position on the root and a hole punched through the top to correspond with the canal, for the insertion of the post. The material most suitable for making the post is square iridio-platinum wire, but it may be made of platinum wire,

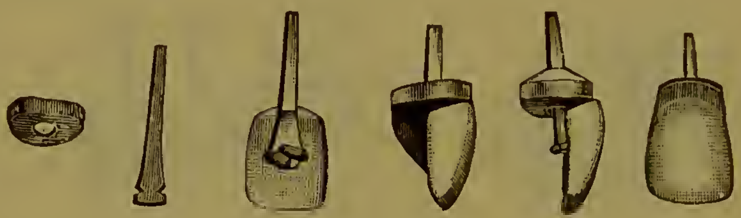


FIG. 910.

either round, square, or three-cornered. The wire is flattened out on one end so that it is broader than the space between the pins of tooth selected, and a notch filed in each side, corresponding with pins, so that it will slip in between them. After measuring root canal to see the length of pin required, the wire is cut off and the end tapered, making a finished post as shown in Fig. 910, 2. It is now placed between the pins, which are bent over as shown in Fig. 910, 3.

"The ordinary plate teeth are used in making these crowns, as will be seen by the cuts, but they may also be made with the plain teeth used for vulcanite work, and sometimes to good advantage. When this kind of a tooth is used, however, the post should be soldered between the pins with pure gold, as the back is not flat like the back of a plate tooth, and it will not be held firmly enough to the post by simply bending the pins over. The tooth is now fitted to the proper position by bending the post if necessary, or grinding the base to let it up if too long; this should be done with the cap in place. The position of the tooth on the cap should now be noted and both re-

moved and well dried. Placing them in their relative position as near as can be judged while out of the mouth, back the tooth up to the cap with hard, sticky wax prepared especially for the purpose. While the wax is still soft, it is set on in position in the mouth to get the articulation exact. The wax is hardened by dropping on to it a little cold water with the mouth syringe, and the crown can then be removed with the cap, without shifting the relative position of cap and tooth. This part of the operation may also be done as follows: After a tooth is fitted and both it and the cap removed and dried, place a napkin in the mouth and dry the root and adjacent parts. Place cap in position, and taking a piece of sticky wax previously prepared, about the size of a pea, warm it and place it directly on top of the cap; then stick post of tooth through the wax, and press it up to position. Whichever of these methods is employed to set the tooth on with wax, it is necessary to see that the palatine side of the cap is down in its proper position before removing it, as the pressure brought to bear on the anterior side by pressing the tooth up to position will tend to tip off the posterior side, especially if the cap is shallow. The wax may now be chilled, and the case removed for investment. In removing, it is best to hook the cap off with a hoe-shaped excavator, instead of removing the tooth with the fingers and depending on the wax to draw off the cap. If the cap should be loose after the piece is removed, which will be the case if there has been any moisture on the cap when the wax was pressed on, take a wax spatula and melt the wax on the cap, and replace in the mouth to be certain the articulation is correct, and remove again. The case will now appear as in Fig. 910, 4. Remove from around the post, with small knife blade or other instrument, any wax which may have been drawn down into the canal while pressing the tooth into position.

"Mix up equal parts of silex and plaster, and fill the cap, building it up, crowning around the post. After the investment sets, boiling water is poured on the case to remove the wax. Fig. 910, 5, shows the silex and plaster in the cap and the wax boiled out. As will be seen, the investment is put in the cap for the purpose of retaining it in position on the post after the wax is removed. If desired, the tooth may be entirely invested and the cap soldered to the post, but this is not necessary unless it is to be used for the support of bridge teeth. The next step is to build on the porcelain body. This is in the form of a powder, and is mixed up with water and applied with a small camel's hair artist's pencil. A color should be selected several shades darker than the base of the tooth, as it requires a darker shade to cover the band and not appear lighter than the tooth, while it is sufficiently translucent so that the thin portion which overlaps the tooth will not

make it look perceptibly darker. It should be mixed as stiff as can be handled with the brush. The post is held with a pair of pliers while the body is applied with the brush, tapping the pliers with the brush handle to jar the body down into the crevices, and smooth off the surface. If it does not run down well between the tooth and cap, wet the brush slightly and apply a little more water, but always work it as dry as possible and still have the surface smooth down when the pliers are tapped with the brush handle. Build out well on the cap and around the front to conceal the band, but do not build down over the pins of the tooth the first time. The piece is now ready for the first fusing. In baking, the crown is placed in the tray of the furnace, which is made of platinum and has a hole through the posterior edge through which to place the post, the tooth being placed face up, resting on the back of the band as shown in Fig. 911. This prevents the piece being fused on to the tray, as the body is not built over the back of the band. The furnace should be heated up very slowly, so as not to check the tooth or throw off the porcelain body by drying it out too quickly. However careful the operator may be, there is always a slight amount of wax left on to the tooth around the pins, which on heating up will burn out, making the body black until it is all burned out. If the case is heated up too rapidly, this will sometimes separate the body from the tooth so that it will not fuse on, especially down near the pins, or it may throw the body off entirely. Great care should be taken, however, to remove all traces of wax before building in any body, and the greatest cleanliness should be observed through the whole process. The pins and post at the place of attachment are now filed or ground off so as not to interfere with the bite. If the bite is very close the back of the tooth may be ground away at the point of contact, so that it will not strike.

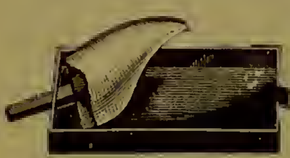


Fig. 911.

"During the first baking the body has shrunken considerably, but it is now built up again, shaped as desired, and fused, making a finished crown, as seen in Fig. 910, 6. In the case of bicuspids and molars, especially when the bite is short, it is often better to build them up entirely with the body, not using any tooth or facing.

"In making these crowns with the ordinary porcelain body, the facing will become etched, or rough and pitted, and on being handled will have black specks over its surface, thus marring its appearance. This is entirely overcome by using Downie's Porcelain Body, which fuses at a temperature so much below the fusing point of the enamel on the teeth that they come out of the furnace as smooth and perfect as they were before baking.

"Another valuable point gained in using this low-fusing body is that one can easily determine when it is sufficiently fused. The white heat required for the high fusing body makes it extremely difficult to see when it is properly glazed; but as this fuses at a red heat, the gloss on the piece can be watched closely, and when it is seen to shine it is done.

"The color of the teeth can also be matched to almost a certainty with our latest improved body. It may be fused just to a glaze, or considerably above, and still be the same color, as the coloring materials are not so fugitive as they are at the higher heats.

"It is the next thing to an impossibility to bake two pieces of the high fusing body at different times and have them come out the same shade; so there is positively no certainty whatever in matching colors with it. A slight difference in the fusing may bleach out the colors so as to ruin the case. Often when the darkest shades of yellow are used, the thin portion around the neck of the tooth in front will bleach out almost white in trying to get a good glaze. No troubles of this kind are encountered if the new low-fusing body is used. Although it was imperfect when put on the market, it has been improved until it has been brought to a remarkable degree of perfection."

The Downie Porcelain Gas Furnace (Fig. 912) will, it is claimed, fuse the Downie body in one and a half minutes, or even less time, and the following directions for using this furnace are given:—

"If properly set up and operated, the porcelain will be fused in the Crowning Furnace, in inlay work, in less than one minute, and crowns in from one and a half to two minutes. This is counting from the time the blast is turned on. Bridges or sections take a proportionately longer time, as they take longer to heat through.

"The body is handled with a brush adapted for that purpose, and mixed up with sufficient water so it can be built on where desired, care being taken not to get it so wet that it will run after it is built on. The crown or matrix, on to which the body is added, should be held with a pair of tweezers while the body is being built on, and the tweezers should be tapped with the brush handle to settle the body down and bring the water to the surface.

"The fresh body should be built the shape desired, and well smoothed over, as it keeps its shape pretty well and will show rough places after firing if care is not taken to smooth down by jarring while wet.

"The tray is then filled with silex and work set upon it in such a manner that the face of the work does not come in contact with the silex, as it would be fused on and destroy the appearance of the piece.

The tray is then put into the muffle, the furnace lighted and very gradually heated up to drive off the water, and if there is a veneer or block in to heat it up gradually and not crack it. This takes but a short time, however, from a half minute for inlays or small crowns, to a

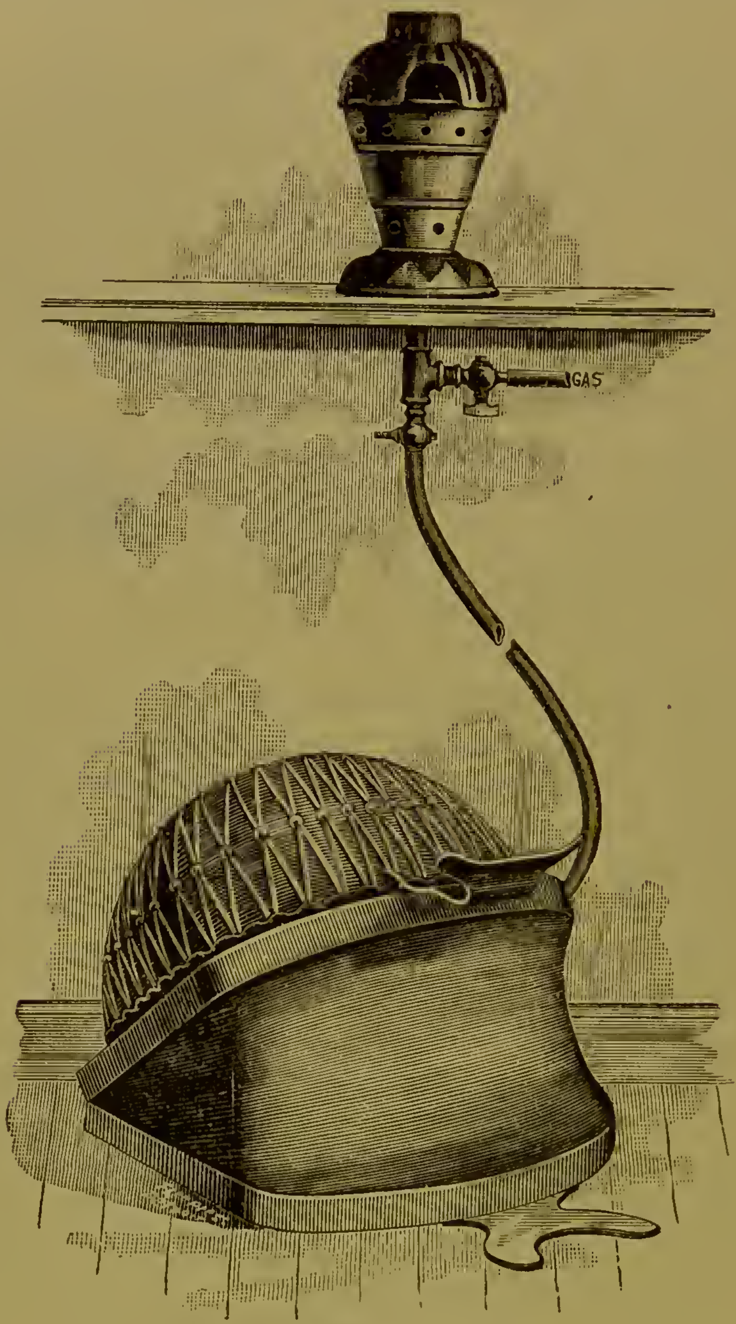


FIG. 912.

minute or minute and a half for large crowns or blocks. Then run the furnace to its full capacity until work is fused. The body should not be baked until it is thoroughly glazed the first time, but merely biscuited, or baked until it is well fused together. Leave in the muffle until it is no longer red, then remove and set in tempering oven, and

let it remain until well cooled down. Add more body to give the required contour and bake until well glazed, letting it cool off gradually.

"In making the Downie Crown, however, do not put any silex in the tray, but stick the pin of the crown through a hole in the back end of the tray, as shown in Fig. 911 on page 800, letting it rest on the pin and the band resting on the bottom of the tray.

"Care should be taken not to let any body or any fusible material get on to the interior of the muffle, as it will fuse the tray to the muffle and injure it in removing the tray. Should such a thing happen, put some silex on the bottom of the muffle.

"Care should also be taken to prevent the contact of any metal with the platinum muffle, as it is likely to make a hole after heating up."

A larger furnace of the same style is used for porcelain bridge-work, gum sections, etc.

Porcelain Bridge-Work.—This style of bridge-work has no joints to retain the secretions, and the gold of other forms of this work may be dispensed with in all places except where it is necessary to make an attachment to a gold cap; and with this exception the natural appearance can be almost perfectly restored. "No gold caps or cutting edges are required to protect the bridge teeth, for precisely the same reason that they are not needed in the crown-work. The crown already described is used as a support for these bridges, the only difference in its construction being that when intended for bridge-work, after setting it up in wax it is invested and the cap and pins soldered. This allows the crown to be set in position without the porcelain backing, and an impression to be taken with modeling compound. A model is run, the bridge teeth are waxed in, and the case invested. After removing the wax a bar of iridioplatinum is fitted from the posts of the supporting teeth across under the pins of the bridge teeth and soldered in position. The case may then be removed from the investment and the porcelain backing added and fused on; when it is necessary to use a gold cap for the support of a bridge, it is made of an alloy of gold and platinum (22 kt. gold); this admits of being soldered with pure gold, is quite hard, so that its wearing qualities are excellent, and goes through the heat of the furnace without oxidation. The bar is soldered to the cap, the porcelain added and fused, and the case handled in every respect as when porcelain crowns are used as supports."

Porcelain Inlaying.—One of the best methods for making them is to burnish platinum foil over and into the cavity, thus forming a matrix, into which the porcelain is built and fused. Body may be added and fused two or three times until the required contour is obtained. The platinum is then peeled off and retaining points or

grooves cut into the porcelain with the edge of a diamond disc ; also undercuts made in the cavity, when the piece is ready for cementing on. The mistake is often made of taking too small a piece of foil with which to make the matrix. This should be large enough to be held easily in position with the thumb and finger of the left hand, while it is being burnished into the cavity with the right. This overlapping foil, by which the matrix is handled, is left on during the process of baking. There are two principal points wherein lie the secret of obtaining a good fit with an inlay : First, in making the walls of the cavity beveled outward for a little way from the margin, so that when the platinum is removed the plug will fit tightly on the margin as it bevels out, and will set in the thickness of the platinum removed, thus taking up the space occupied by it, and making a perfect fit at the margin ; second, in only partially filling the matrix with body the first time it is baked, then replacing in the cavity and burnishing down the edge again ; this corrects any springing of the matrix. For labial cavities, where there is no force to be exerted which will tend to loosen the filling, they may be set with Hill's Stopping, using a warm instrument handle to press them into place. This is perhaps more reliable as to lasting qualities than any cement which we have at the present day.

The Jacket Crown.—"This is a platinum cap with a porcelain facing, and is in certain cases very valuable ; its use is indicated for undeveloped teeth, usually called rice or peg teeth. These may be built out and the normal appearance fully obtained. It is also of use in cases of badly decayed teeth where the pulp has receded considerably and is in a healthy condition ; it is of no use for decayed teeth of normal size if the nerve has not receded and they set in their proper position in the arch, because they must be ground so near to the pulp in order to get the facing on without its being too prominent that the death of that organ is almost sure to result. There is no good reason why they should ever be used in any case where the pulp is not alive.

"To construct this crown, make a deep band or ferrule of platinum to fit the tooth, which has previously been ground slightly tapering on its sides and lingual surface, and flat (receding considerably) on the labial surface. The inner portion of the band, which stands up from the tooth, is clipped off and a flat piece soldered on to make the sloping lingual surface (supposing the crown to be an incisor or cuspid), and the anterior portion of the band ground very thin, except around the gum margin. This thin anterior portion is malleted down against the tooth, using a large foot plugger, and folding down the upper corners when necessary. A tooth is selected, either a flat back or a plain tooth for rubber work ; it is ground away flat at the back, tapering down to

as thin an edge as possible at the base; after grinding until it will set in the proper position, the cap is removed and the facing stuck on with a little porcelain body. The piece is then set on a tray in which is a little ground silex to keep it from shifting around while in the furnace. It should be very carefully heated up, in order that the facing may not be thrown off. When cool, more porcelain is added around the edges to securely attach the facing, and, after fusing, the crown is ready to be cemented in place. All these operations in porcelain are made infinitely more practical by the use of the low-fusing porcelain body, which enables us to bake crowns without etching the face of the tooth, to fuse on to a bridge which is soldered to a gold cap, and to match the colors almost perfectly."

Dr. C. H. Land has devised what he calls "metallic enamel coatings and sections," which he describes as follows:—*

"The accompanying engravings, Figs. 913 and 914, are taken from

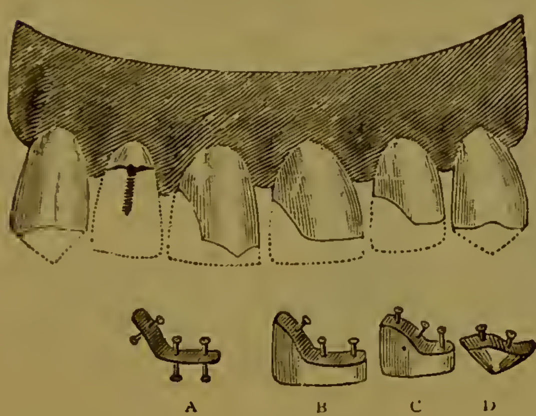


FIG. 913.

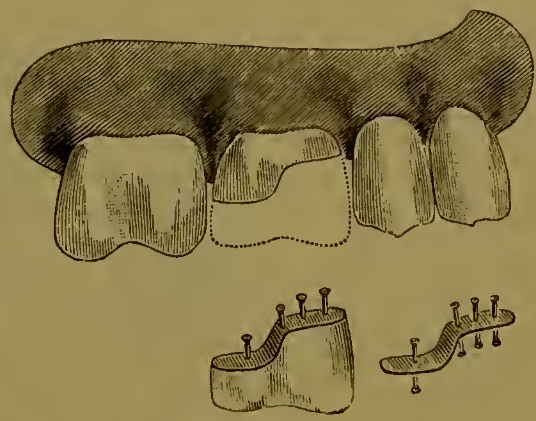


FIG. 914.

practical cases that have at this date been in use for one year. In the case represented by Fig. 913, the patient was about sixty years of age. The right lateral incisor was prepared with a Howe post, shown in its relative position. The five remaining teeth, after the cavities were prepared, contained tooth substance as represented by the dark surfaces, the white representing the lost portion of each tooth, restored with sections of porcelain made to imitate the exact color and contour of the original tooth substance. The cavities are prepared as for gold filling, when a thin piece of annealed platinum plate, No. 35 standard gauge, is placed over the tooth, and by means of burnishers made to take a perfect impression of the outer rim of the cavity, after which platinum pins are attached, as shown at A. The object of the pins is to serve as a fastening, both for the porcelain paste or body and as retainers to hold the completed section in the cavity of the tooth. The

* *Independent Practitioner.*

porcelain paste or body is built upon the platinum disc and made to imitate the lost portion of the tooth. It is then baked in a gas furnace, requiring but twenty minutes for the first biscuit and fifteen for the second, and when finished appears as shown at B, ready to be cemented with oxyphosphate. C and D are modifications for the other teeth, and Fig. 914 illustrates porcelain facings for molars.

"The especial feature of this system is the large amount of tooth substance preserved above the gum, there being no necessity for telescoping the root so far below as to sever the tissues. This mode of practice also dispenses with the long operations and protracted use of the rubber dam; it almost entirely obviates the use of amalgam, and saves the necessity for large gold fillings; there is no malleting, no long and tedious operation either for the patient or dentist, while at the same time teeth are perfectly restored, both in appearance and usefulness.

"There is another advantage in the use of the enamel coatings which is not, in my opinion, a trivial matter. When large metallic fillings are inserted, the constant thermal changes consequent upon their alternate heating and cooling must exercise an unfavorable influence upon the tissues about the tooth. Even if the pulp be dead and the root be filled, there will be a checking and fracture of the tooth in time from the continually varying changes of temperature. An inflammation of the membranes will also be likely to occur from the same cause, and thus the tooth will in time be lost, from the mere influence of the presence of a large mass of metal.

"It is also a fact that large gold fillings cannot be inserted without so much malleting that the strength of the tooth is gone, and frail walls are cracked beyond the possibility of repair. These dangers are all obviated by the use of the porcelain facings, while teeth so restored are much more natural in feeling and more grateful to the touch of the tongue than any metallic filling can be."

Dr. Land describes his metallic enamel sections as follows:—

"By reference to Fig. 915, Nos. 2, 7, 10, 12, and 15, there will be seen characteristic conditions of decay suitable for this class of work. 2 and 7 are the prepared cavities on anterior sides of molars. The manner of procedure is to burnish a thin piece of annealed platinum plate into the cavity. This takes a perfect impression of its outlines. The surplus edges are trimmed off and platinum pins attached, using pure gold leaf for solder. (See 3 and 4.) The pins serve as a fastening, both to secure the completed section in place and as retainers for the porcelain body. 5 and 8 illustrate the completed sections, showing the contour of the original shape of the lost portion of the natural tooth. Nos. 1 and 6 are prepared sections cemented in place.

"Having secured the prepared sections as shown in 3 and 4, porcelain paste or body is built upon them and carved so as to imitate

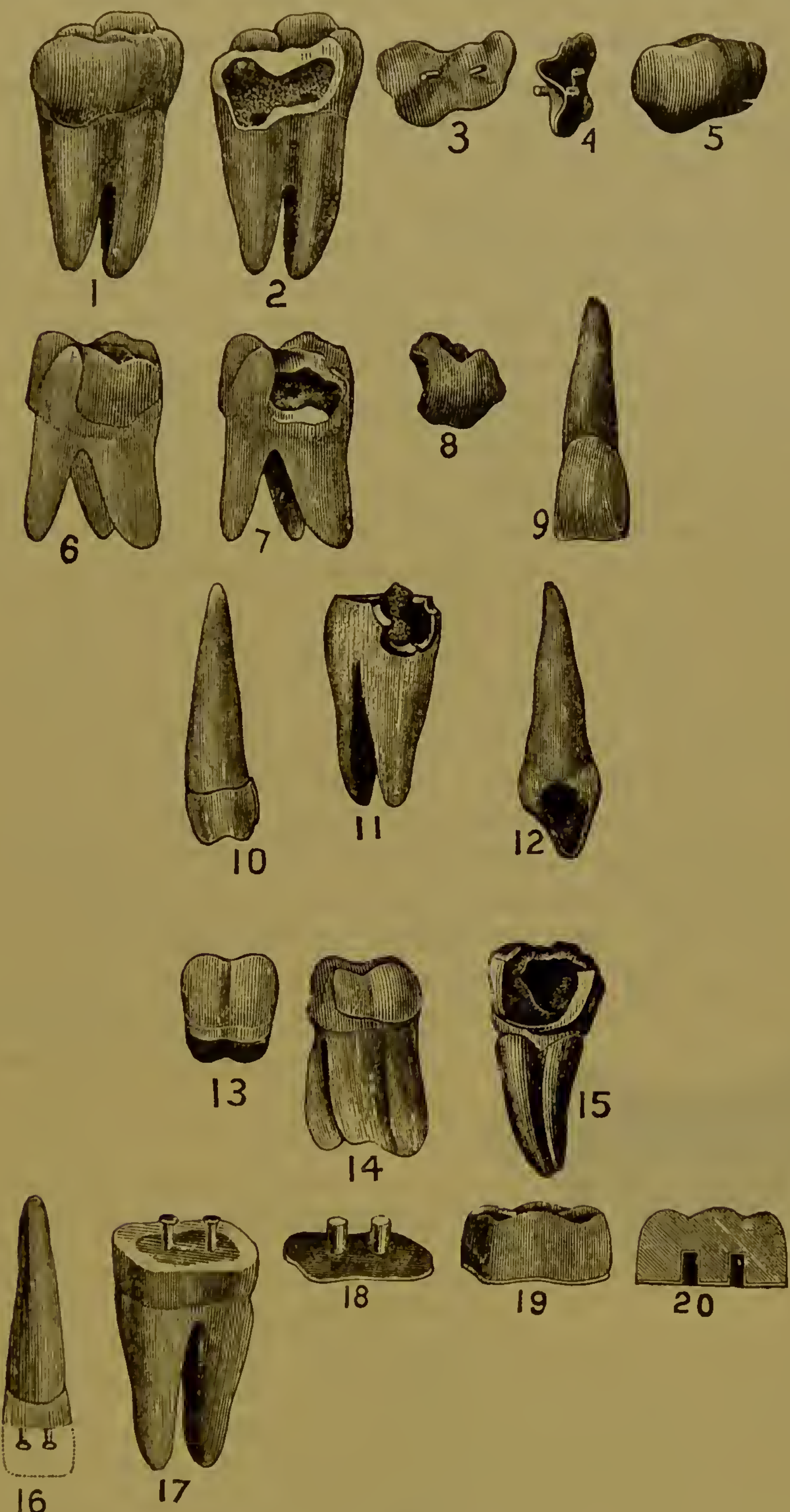


Fig. 915.

the original contour of the lost portion of the tooth, as shown in 5 and 8. They are then placed on a bed of silex and fused in a gas

furnace. This requires twenty minutes for the first biscuit and fifteen for the second. When completed, they will be a reproduction in porcelain of the lost parts of the natural organs, resembling nature perfectly, both in color and shape. They are then cemented in the cavity, either with gutta-percha filling or oxyphosphate cement. When the anterior side of a molar or bicuspid is decayed, as shown in 11 and 15, the enamel front or veneer, 13, is added to the porcelain body, and when completed it will appear as shown in 14. This veneer serves as a ready and efficient means of securing the proper shape and contour of each class of teeth. To those who are not familiar with the use of a gas furnace this class of work may seem difficult, but a little experience with the modern appliances now within the reach of every dentist makes the operation a comparatively simple and easy one. 17, 18, 19, and 20 are a modification. 17 represents a tooth filled with gold, having two pins attached. 18 is a platinum disc, with tubes adjusted to correspond to the position of the pins in 17. Porcelain body is built about the tubes, and when fused in the furnace the whole will form a porcelain crown, as shown in 19. 20 illustrates the relative position of the tubes, which are designed to form countersinks for the pins in 17. When cemented in place, it makes a very durable and beautiful piece of work. 16 is an incisor constructed in a similar manner. From this will be seen the great advantage of being able to have the porcelain in a plastic state, as it enables the dentist to perfectly adapt the form of each peculiar case with the utmost precision, and this could not be so admirably done with manufactured crowns.

"I wish to call especial attention to the large amount of tooth-substance preserved. In nearly all the modern systems of crown-work there seems to be too much good tooth-material cut away, and I think a careful investigation will demonstrate this new process to be far superior, making it possible to save the greater portion of the crown, it not being necessary to cut beneath the gum. In nearly every case, sufficient tooth-substance can be retained to preserve the pulp alive, and when the teeth are devitalized the major portions of the crown can be left intact, serving for retaining purposes and making it unnecessary, in the majority of cases, to resort to screws or posts. 16 illustrates a section of porcelain adjusted to a central incisor, which, when carefully done, makes a very acceptable piece of work. Although the joint may sometimes be conspicuous, it is not nearly as much so as a glaring piece of gold."

Fig. 916.

Fig. 916 represents a practical case for the insertion of the sections.

In concluding the subject of artificial crowns attached to natural roots and teeth, it remains only to briefly refer to the advantages and disadvantages of each method. As regards what is strictly pivot work, all methods are objectionable in which the exposed surface of the root is not protected from such agents as disintegrate tooth structure; as regards the collar or ferrule crown, such work is objectionable where it causes irritation of the gum and periosteal tissues, or permits of the disintegration of the supporting roots or teeth, or is temporary in its nature, on account of the use of the plastic preparations in connection with it; and lastly, all "bridge" or crown-work is objectionable where it cannot be kept perfectly clean and free from accumulations of fluid and other substances beneath it, and where it cannot be repaired in case of accident without breaking up the entire appliance. The effects of thermal changes on tooth tissues when brought directly in contact with large masses of metal, and the exceedingly frail nature of many of the porcelain crowns and facings required by some of the methods in use, should also be considered.

To grind the Logan tooth-crown, it has been suggested to take a hollow mandrel and, while in a hand-piece, heat the end and mount on it a corundum wheel, such as No. 00, being careful to make its outer face true and leave the hole in the end of the mandrel free for the pivot or post of the tooth-crown to enter. The neck of the Logan crown can then be ground without the risk of grinding the post or pivot, which enters the socket of the mandrel and is protected.

Solid gold cusps made of twenty-two carat gold and designed to be soldered to gold bands fitted to natural roots, and also for forming the masticating surfaces of porcelain crowns in bridge-work, can be obtained at the dental depots or be made by stamping thick gold plate with hard metal dies.

CHAPTER VI.

MANNER OF REFINING AND ALLOYING GOLD, AND CALCULATING ITS FINENESS.

Gold is the best metal, and for general use the best material, that can be used for the attachment of artificial teeth. When used of proper fineness it resists the most acrid secretions of the mouth, and undergoes, during the long years of use, no change in its strength, form, or texture. Other metals and materials have a special utility, but none have so wide a range of usefulness, and none can take the place which this royal metal holds in dental prosthetics.

Gold in its pure state, free from alloy, is too soft and yielding to serve as a suitable support for artificial teeth; and, on the other hand, if it contains too much or an improper alloy, it will become tarnished by the secretions of the mouth, rendered too brittle for service, through those molecular changes which take place, with greater or less rapidity, if the plate is less than twenty carats fine. It is, therefore, of the utmost importance that the gold used in connection with artificial teeth should be of the proper fineness and possessed of the requisite malleability. To secure these qualities, it is necessary to know the kind and quantity of metal with which to alloy it before it is made into plate or other forms necessary for the purposes for which it is to be employed.

Gold clippings, filings, and scraps generally, if free from admixture with base metals, only require to be remelted if of a required fineness; but gold clippings, filings, and other scraps and parts of old gold plate or bridge-work, as found in the laboratory, are apt to become mixed with base metals, such as iron from the wearing of files, and occasionally small particles of lead, tin, zinc, or fragments containing solder If these are melted with and permitted to remain in the gold, they will destroy its ductility and render it unfit for use. Iron, less objectionable than the lead or tin, may be removed with a magnet before the gold is melted; but to free it perfectly from the others, it will sometimes be necessary to refine it by roasting, or to reduce it to pure gold by the humid process in the manner presently to be described. A two-thousandth part of tin or lead destroys the ductility of gold, and even exposure to the fumes of red-hot tin or lead renders it exceedingly hard and brittle.

The sweepings of a laboratory contain many impurities, both earthy and metallic, and they should be treated by either first washing thoroughly to remove the earthy matter, and the remaining metal refined separately. A better process, however, is to burn out the combustible substances, and then mix the residue with the following substances: to every eighth part of the sweepings add carbonate of potassa four parts, chlorid of sodium four parts, supertartrate of potassa one part, and nitrate of potassa half part; place in a crucible and subject the contents to the fire for some time after fusing occurs. As different affinities exist between metals, the selection of a reagent is governed by the nature of the alloy in the process of separating gold from foreign metals. Zinc or iron, or both of these metals, if present in gold in small quantities, may be separated by nitrate of potassa, as it yields oxygen, which has an affinity for such metals and converts them into oxids. Tin is more readily separated from gold by chlorid of mercury, for the reason that oxygen has a feeble affinity

for tin, whereas chlorin in the act of decomposition separates the tin from the gold very readily. When gold is contaminated with a number of these metals, which render it very coarse, the most powerful and efficient reagent is sulphuret of antimony, or resort may be had to the humid process and the alloy thereby reduced to pure gold. Antimony or bismuth, when mixed with gold, also renders gold hard and brittle. So marked is the influence of antimony in injuring one of the most valuable properties of gold, that its original name, *regulus* (little king), by which it is best known in commerce, was given in view of this controlling effect upon the king of metals. It is of the utmost importance to bear in mind the action of minute quantities of these four metals, so much used in the laboratory, upon gold, platina, and silver.

Platina, united with gold in certain proportions, has the effect of hardening the latter metal and making it very elastic, but does not materially affect its ductility. The affinity of the alloy for oxygen, however, is so great that it is readily acted on by nitric acid. The acids of the mouth will often make this alloy very brittle. But for this, the two metals, combined in the proportion of the fifteen parts of gold to one of platina, would form an exceedingly useful alloy for the construction of spiral springs. That a combination of two metals should be thus easily acted on by an agent incapable of acting on either when in a separate state may appear somewhat remarkable, but it is, nevertheless, true. We have in the effect of platina upon steel an analogous case. It makes the steel exceedingly hard and fine-grained; but although itself totally insensible to the action of oxygen, when alloyed in minute quantity with steel it causes this latter metal to oxidize with such readiness as to make it unfit for use.

Hence may be seen the fallacy of the idea, entertained by many, that because platina is a more indestructible metal than silver or copper it must necessarily make a purer plate. The properties of alloys are, in fact, so often and so widely different from those of their component metals that they can be ascertained only by experiment. Of the three metals, platina, silver, and copper, speculative theory might select the first and purest as the best alloy for gold; whereas, actual experience demonstrates that copper, itself the most injurious to the mouth, imparts most perfectly to gold, if kept within proper limits, those qualities which are required in a dental plate.

In view, then, of the importance of having gold which is to be placed in the mouth of the right quality, every dentist who has connected with his practice a mechanical laboratory should have the necessary fixtures for melting and working this metal into the various

forms required for dental purposes. The principal of these are, a small furnace, with crucibles and tongs, ingot-molds, an anvil and hammers, and a rolling mill; a plate gauge, draw plate, and bench vise; fluxing and refining chemicals, etc.

REFINING GOLD.

It is not our intention, in describing the manner of refining gold, to enter into a minute detail of the various methods employed for assaying or refining this metal, but to point out as briefly as possible the manner of separating it from the several metals with which it is most frequently combined in the dentist's laboratory. The two methods generally employed for separating gold from foreign metals are the "dry" and the "humid" processes, the former being a "roasting" process effected by the action on the alloy in a molten condition of either oxygen, chlorin, or sulphur; while the latter process (humid) reduces the alloy to pure gold by the solvent action of either nitric, sulphuric, and nitro-muriatic or hydrochloric acid.

The method usually employed by assayers for separating gold from silver is to roll the alloy out into very thin plates, and put it in nitric acid; this will dissolve most of the silver, and leave the gold behind in the form of brown plates, scales, or powder, which, after being thoroughly washed, is put into a crucible with borax and melted down into an ingot of pure gold. But this method will not succeed unless the quantity of silver be equal to two or three times that of the gold; for the nitric acid, which acts only upon the silver (and copper), cannot eat out all the alloy if its particles are too much surrounded with the particles of gold. From the old rule—one-fourth gold, three-fourths alloy—came the name given to this process, *quartation;* it is also known as the *nitric acid* process. It is well adapted to the purification of gold upon a large scale, and is the process used in the U. S. Mint. But it does not remove the platina so generally found in dentists' scrap; and it is not so well adapted for gold of 18-carat fineness and upward as the next process.

The nitro-muriatic or *aqua regia* process dissolves all the metals of the alloy, but immediately precipitates the silver. The gold is subsequently precipitated in a state of purity, thoroughly washed, dried, and melted down with borax. The process is, briefly, as follows: Melt the scrap to be refined; roll into a thin strip and curl it up into what is technically termed a *cornet;* place in a porcelain vessel and pour on the aqua regia, three or four ounces to the ounce of alloy, which must be mixed at the moment of using in the proportion of one part of pure nitric acid to two, two and a half, or three parts of hydrochloric acid; quicken the solution by heat from a spirit-lamp,

setting the vessel where the nitrous fumes can escape from the room; decant or filter the solution so as to separate the precipitated silver; evaporate the clear solution over a spirit-lamp, nearly to dryness, add hydrochloric acid, and evaporate a second time, so as to get rid of all nitric acid.

The concentrated orange-colored solution is the chlorid of gold together with the chlorid of platina and other metals, from which it must be separated by precipitation. Dilute largely with water, and add, little by little, a solution of the protosulphate of iron (green-vitriol), until the dark olive-brown precipitate, which instantly appears, ceases to form. Pour on this precipitate some sulphuric acid, to remove all traces of iron, and then wash several times with hot water, dry it, and melt with borax in a crucible.

Another method of refining is the *sulphuric acid* process, which it is unnecessary to describe further than to say that it resembles the *quartation* process. Gold is melted with five to seven times as much silver, granulated, and then boiled three or four hours in a platina or iron retort with sulphuric acid.

The late Prof. George Watts' process of refining gold by the "humid" or "wet" process, the solvent being nitro-muriatic or hydrochloric acid, which appears to give the most convenient results, is as follows:—*

"Let us then suppose that our gold alloy has become contaminated with platinum to such an extent that the color and elasticity of the plate are objectionable. The alloy should be dissolved in nitro-muriatic or hydrochloric acid, called *aqua regia*, the best proportions of which are three parts of hydrochloric to one of nitric acid. Four ounces of the aqua regia will be an abundance for an ounce of the alloy. If the acids be 'chemically pure,' four parts of the hydrochloric to one of the nitric produces still better results.

"By this process the metals are converted into chlorids; and as the chlorid of silver is insoluble, and has a greater specific gravity than the liquid, it is found as a grayish-white powder at the bottom of the vessel. The chlorids of the other metals, being soluble, remain in solution. By washing and pouring off, allowing the chlorid of silver time to settle to the bottom, the solution may be entirely separated from it. The object is now to precipitate the gold while the others remain in solution. This precipitation may be effected by any one of the several different agents, but we will mention only the protosulphate of iron.

"This salt is the common green copperas of the shops, and as it is

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* *Dental Register.*

always cheap and readily obtained, we need look no further. It should be dissolved in clean rain-water, and the solution should be filtered, and allowed to settle until perfectly clear. Then it is to be added gradually to the gold solution as long as a precipitate is formed, and even longer, as an excess will the better insure the precipitation of all the gold. The gold thus precipitated is a brown powder, having none of the appearances of gold in its ordinary state. The solution should now be filtered, or the gold should be allowed to settle to the bottom, where it may be washed after pouring off the solution. It is better to filter than decant in this case, as, frequently, particles of the gold float on the surface, and would be lost in the washings by the latter process.

"Minute traces of iron may adhere to the gold thus precipitated. These can be removed by digesting the gold in dilute sulphuric acid, and, when the process is properly conducted thus far, the result is *pure gold*, which may be melted, under carbonate of potash, in a crucible lined with borax and reduced to the required carat."

By any of these processes, but most conveniently by the second, dental scrap may be refined to a purity sufficient for every practical purpose.

The Dry Process.—The form of furnace for melting gold depends much upon the kind of fuel. Charcoal, coke, and anthracite are the three kinds used; bituminous coal is inadmissible until converted into coke. The plumbing stores and stove factories now furnish so many convenient forms for the use of gas and many of these fuels that we shall not occupy time or space in their detailed description. A pipe six feet high will give to the ordinary "preserving furnace" a draft sufficient to melt gold with charcoal; coke gives a very intense heat, but needs a stronger draft; anthracite requires a powerful draft, but gives a more steady heat, needs less frequent renewal, and hence is better for long-continued heats.

As regards the shape and size of the furnace, the following points should be attended to: convenience of access to the crucible; sufficient depth and width to surround the crucible with a good body of fuel, without unnecessary waste of material.

Fletcher's small and convenient blast crucible furnaces, for melting gold by the use of gas and refined petroleum, are very serviceable in laboratory work.

Downie's crucible gas furnace (Fig. 917) is especially designed for melting metals, such as gold and silver, making alloys for amalgam, experimental work, etc. It is also very useful for brazing, soldering, heating up bridge cases or metal plates to solder, etc.

It has two removable rings of different widths, which set on above

the flaring base to carry the heat up around the crucible, the wide or narrow ring to be used, according to the size of the crucible, or both rings may be put on at the same time.

It also has a conical-shaped top which can be set on above the rings to confine the heat when it is desired to fuse any high-fusing substance.

For separating iron, copper, tin, lead, or zinc from gold, the following simple method may be adopted: After passing a magnet a number of times through the filings or fragments, to remove all traces of iron or steel, put the gold in a clean crucible, covered with another cruci-

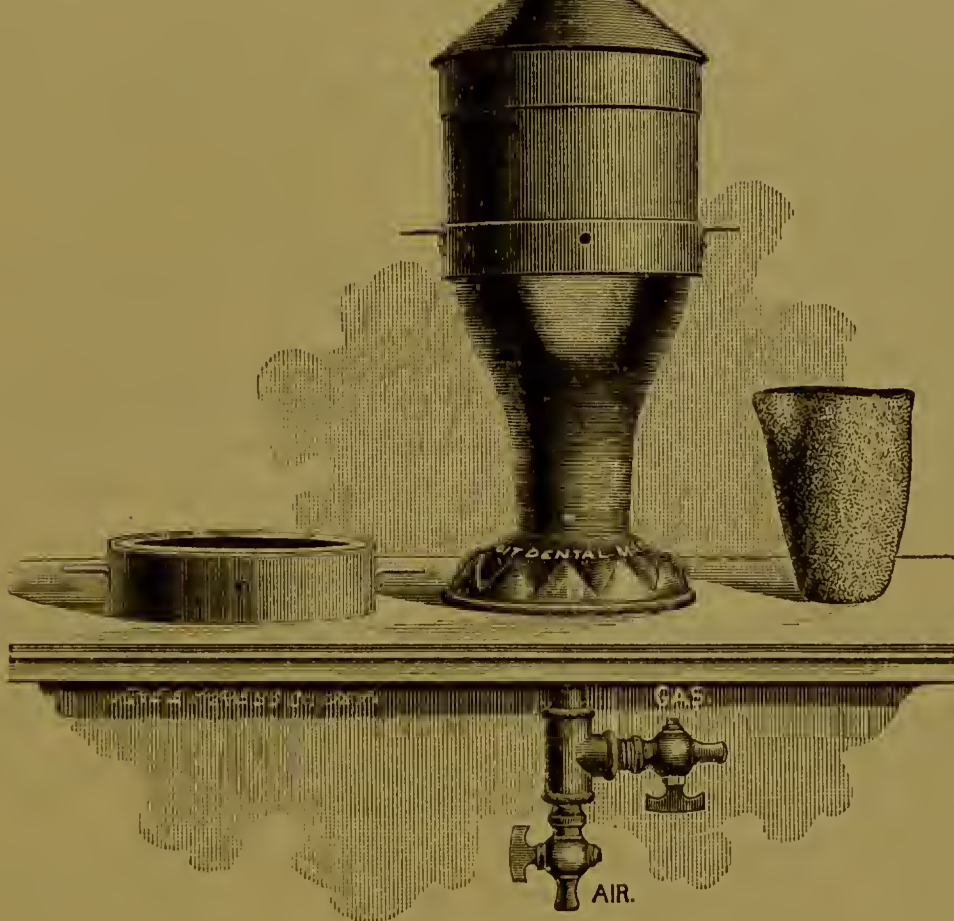


FIG. 917.

ble, having a small opening or hole through the top; lute the two together with clay; place them in a bed of charcoal in the furnace; ignite the coal gradually; afterward increase the combustion by means of a current of air from a pair of bellows, or by turning on the draft; after the gold has melted throw in, at intervals of about ten minutes, several small lumps of nitrate of potash (saltpeter) and sub-borate of soda (borax), and keep in a fused state for thirty or forty minutes; then remove the crucible and plunge in water to cool it; break it and separate the lump of gold from the dross; then put into

another crucible; melt with a little borax, and pour into an ingot-mold of the proper size, previously warmed and oiled. Bichlorid of mercury (corrosive sublimate) is sometimes used instead of or after nitre, for the purpose of dissipating the base metals, and often with more certain and better results, especially where the presence of any tin is suspected. If the gold cracks on being hammered or rolled, it should be melted again, and more nitre and borax thrown in; the inside of the crucible should also be well rubbed with borax before the metal is put in. It is sometimes necessary to repeat this process several times, and if the gold still continues brittle, a little muriate of ammonia (sal ammoniac) may be thrown into the crucible when the gold is in a fused state; after the vapor ceases to escape, the metal should be poured into an ingot-mold, warmed, and oiled as before directed. This last method of treatment will make the gold tough, and prevent it from cracking under the hammer or while being rolled, provided it is from time to time properly annealed during the process.

To separate tin and lead from gold, add corrosive sublimate ($HgCl_2$), and chlorid of zinc ($ZnCl_4$) or chlorid of lead ($PbCl_2$) are formed and with the mercury are volatilized. To separate silver from gold, from two to four times the weight of the gold of sulphid of antimony (Sb_2S_3) must be added in small quantities, the sulphid being decomposed by heat. The sulphids are formed by the sulphur uniting with the silver and other base metals, and the antimony unites with the gold, forming a leaden-colored alloy in the bottom of the crucible, while the sulphids remain on the surface. The antimony is separated from the gold by remelting the alloy and throwing upon the fused mass a current of air from a blowpipe. The oxid of antimony (Sb_2O_3) is thus formed, which is volatilized, and the process continued until fumes can no longer be driven off.

To remove iridium from gold, the latter is alloyed with three times its weight in silver, and the mass melted in a crucible, by which means the specific gravity is so greatly lowered that the infusible iridium subsides to the bottom of the crucible, when the gold and silver alloy can be poured off. As some of the gold still remains with the iridium, more silver must be melted with it and the process repeated as often as is necessary to remove all of the gold. The silver is then separated from the gold by the process already described. Platinum can only be removed from the gold by the humid or wet process.

By this method of refining gold, known as the *dry process*, or "refining by fire," sufficiently accurate results will be obtained for many of the practical purposes of prosthetic dentistry, since the

variation of an eighth or a quarter of a carat in the fineness of gold plate is not often a matter of much consequence. Comparing the two classes of refining processes—the *humid*, by acids, and the *dry*, by fire—the first is the most accurate, and the only way to remove platina or silver; but it is the most troublesome, and requires a familiarity with chemical details, which, unfortunately, many dentists are totally ignorant of. The second may remove the lead, tin, zinc, antimony, and bismuth, if in small quantity; and if continued for a sufficient length of time, with a free use of nitre, may remove a large proportion of copper. It can scarcely be depended upon if the object is to make an ingot of pure gold, but will answer admirably if the purpose is merely to lessen the alloy or remove certain impurities.

A very excellent method pursued by Dr. Elliott, of Montreal, is as follows: *—

"The following implements are necessary for this purpose: a small draft furnace; a quantity of fine hard-wood coal; a clean crucible, with a sheet-iron cover (a lump of charcoal is better); a light pair of crucible tongs; an ingot mold, made of soapstone; a little nitrate of potash, carbonate of potash, borax, and oil. The fireplace of the furnace should be about ten inches in diameter and eight or ten deep; this should be connected by means of a pipe with the chimney, so that a powerful draft may be made to pass through the coal. A blast-furnace is objectionable, for the reason that the bellows burns out the coal immediately under the crucible, and it is, therefore, constantly dropping down, which is not the case with the draft furnace; besides, the draft furnace produces a more even fire, a quality equally indispensable.

"In preparing for a heat, the furnace should be filled about half full of coal, and after it is well ignited it should be consolidated as much as practicable without choking the draft. The crucible containing the metal and a little borax may then be set on, and more coal placed around and over it, the door of the furnace closed, and the damper opened. It should remain in this way until the gold is perfectly fused. The coal may then be removed from over the crucible, and a bit of nitrate of potash dropped in, in quantity equal to the size of a pea to every ounce of gold, and the crucible immediately covered with a plate of iron. More coal may then be placed over and around the crucible, and the gold kept in a fused state at a high temperature, until the scoria ceases to pass off, which it will do in the course of five or six minutes. The ingot-mold, having been

* *American Journal of Dental Science.*

previously warmed, should be placed in a convenient position for pouring, and filled about half full of lamp oil. The cover should now be thrown off quickly, the crucible seized with the tongs, and at the same instant another small bit of nitrate of potash should be thrown into it, and the gold rapidly, but carefully, poured into the mold.

"The ingot always cools first at the edges, and shrinks away from the middle. On that account, the mold should be a little concave on the sides, so that the shrinking will not reduce the ingot thinner in the center than at the edges.

"Molds of the best form will sometimes produce ingots of irregular thickness. Such ingots should be brought to a uniform thickness under the hammer, using the common callipers as a gauge. If this be neglected, the plate will be found imperfect at those points where the ingot was thinnest. The plate should be annealed occasionally during the process of hammering and rolling, and should be reduced about one number in thickness each time it passes between the rolls. If any lead, tin, or zinc be mixed with the gold, the nitrate of potash must be used in much larger quantities, and, in that case, it is better to let the button cool in the bottom of the crucible. Then break the crucible and melt it in a clean one for pouring, using borax and nitrate of potash in very small quantities for the last melting.

"In case the subject of assay be in the form of filings or dust, a magnet should be passed through it, so as to remove every particle of iron, and then, instead of melting it with borax, it should be melted first with *carbonate* of potash, and afterward with *nitrate* of potash, in quantities proportioned to the necessities of the case, as before directed. Carbonate of potash is the only flux that will bring all the small particles of metal into one mass. Without it, a great portion of the gold will be found among the scoria, adhering to the sides of the crucible, in the form of small globules. This process of refining answers equally as well for silver as for gold."

ALLOYING GOLD.

Gold, when in an unalloyed or pure state, as before stated, is too soft to be used as a support for artificial teeth; consequently, it has been found necessary to combine with it some other metal, in order to harden it. Silver and copper are the alloys most frequently employed. Many dentists prefer the former, erroneously supposing that it does not increase the liability of gold to tarnish as much as the latter. But this opinion is sustained neither by facts nor experience. Gold, when alloyed with copper, unless reduced altogether too much for dental purposes, will resist the action of acids as effectually as when alloyed with silver, and the former renders it much harder than

the latter. Besides, it renders the gold susceptible of a higher and more beautiful finish. If, therefore, but one of these metals is used, copper may be regarded as preferable to silver.

The gold employed in prosthetic dentistry by most practitioners is altogether too impure for the purpose, it being not more than eighteen carats fine, and sometimes it is reduced even to fourteen. When not above these standards of fineness it is discolored by the buccal secretions, imparts a disagreeable taste to the mouth, and becomes brittle after it has been worn for a few years. The plate which is to serve as a basis for artificial teeth should never be reduced below twenty carats; and as that for the upper jaw does not require to be more than one-third or one-half as thick as that of the lower, the gold for the latter may be a little finer than that employed for the former, as it is necessary that it should be more malleable. The following standards of fineness may be regarded as the best that can be adopted for gold used in connection with artificial teeth: plate for the upper jaw, twenty carats; for the lower, twenty-one; and for clasps and wire for spiral springs, eighteen.

In reducing perfectly pure or twenty-four carat gold to these standards, first make an alloy of copper and silver, which may be either in the proportion of copper 4, silver 1, or copper 9, silver 1, according to the qualities required in the plate. The effects of the two metals are in strong contrast—copper giving hardness and elasticity, and deepening the color into a red; silver preserving the softness, and giving a greenish-white shade to the original yellow of the pure gold. Of these alloys take—to twenty-one grains of pure gold, three grains; to twenty grains of pure gold, four grains; and to eighteen grains of pure gold, six grains; to make, respectively, twenty one, twenty, and eighteen-carat gold. In the latter case, the alloy should be used containing most silver, as so large a percentage of copper makes the gold too hard and elastic, and gives it rather too red a color.

The gold should be first melted in a clean crucible, and as soon as it has become thoroughly fused, the silver and copper alloy may be thrown in, with two or three small lumps of borax. After keeping the whole in a melted state for some five or ten minutes, it should be quickly poured into an ingot-mold of the proper size, previously warmed and oiled. If the gold cracks during the process of hammering or rolling, it must be melted again and a few small pieces of borax with a little muriate of ammonia thrown in, and in five or ten minutes recast into an ingot.

When scraps and filings are to be converted into plate they should first be refined, afterward properly alloyed. This may also be neces-

sary with all gold the quality or fineness of which is not known; but with national coins having a known fixed standard this will not be necessary. When they are above these standards of fineness, the amount of alloy necessary to reduce them to the required fineness may be readily found by calculation. It is often unnecessary to change the fineness of either American (21.6 carat) or English (22 carat) coin; especially when the depth of the plate in upper cases, or the prominence of the ridge in lower, gives additional stiffness to the plate.

There are two principles upon which plates are alloyed. The first, and common one, is to add as much alloy as the gold will stand; the second is to add the least possible quantity. The first results in eighteen-carat gold, and uses mainly silver, lest the six grains of alloy should make it too brittle. The last results in twenty or twenty-two-carat gold, and uses chiefly or exclusively copper, since the least quantity of this gives the greatest stiffness.

The simple rule is to have the purest plate which the form of the mouth will permit. For shallow mouths, requiring increased stiffness, a twenty-carat plate may be used; but better practice still is to increase the rigidity by greater thickness, or sometimes by doubling some part of the plate.

In connection with the alloying of gold, it is proper to make some remarks upon the terms in which the fineness of alloys is expressed, and the means of ascertaining it.

Pure gold being taken as the starting-point, it may be expressed by unity (1), or by 24, or by 1000. In the first case, fineness is given in *fractions*. In the second case by parts called *carats*, which, for convenience, may be considered as equivalent to a grain; thus representing pure gold by 24 grains, or 1 dwt. In the third case, value is expressed in *decimals*, and is the most convenient system, although the second is the most customary with jewelers and dentists.

The following table, prepared by the late Prof. Austen, will show the relative value of these three systems in a few of the most usual forms of gold alloy:—

	FRACTIONS.	CARATS.	DECIMALS.
Pure gold,	1.	24.	1000.
English coin,	$\frac{11}{12}$	22.	916.6
American coin,	$\frac{9}{10}$	21.6	900.
Dentists' gold, best,	$\frac{5}{6}$	20.	833.3
" " good,	$\frac{4}{5}$	19.2	800.
Jewelers' gold, best,	$\frac{3}{4}$	18.	750.
" " good,	$\frac{5}{8}$	15.	625.
" " common,	$\frac{1}{2}$	12.	500.
Commonest solder,	$\frac{1}{3}$	8.	333.3

The table gives the amount of pure gold; subtracting which from the number at the head of each column will give the amount of alloy. For example: best jewelers' gold contains 18 carats of pure gold and 6 carats of alloy; or three-fourths pure gold and one-fourth alloy; or 750 parts pure gold and 250 parts alloy.

To know how much alloy is required to reduce gold from one fineness to another, Prof. Austen gives the following rule: *Divide the lower carat* (c) *by the difference between the lower carat* (c) *and the higher* (C); *divide the weight* (W) *of the gold by this quotient* (c ÷ (C — c)), and it will give the amount of alloy (A) to be added. He also gives the following table of DIVISORS, which will be found convenient, as saving the necessity of much calculation:—

CARATS.	22.	21.	20.	19.	18.	16.	14.	12.
24.	11.	.7	.5	3.8	3.	2.	1.4	1.
22.		21.	10.	6.3	4.5	2.6	1.7	1.2
21.6		35.	12.5	7.3	5.	2.8	1.8	1.3
20.				19.	9.	4.	2.3	1.5
18.						8.	3.5	2.

The first vertical column represents the fineness *before* alloying; first horizontal column the fineness *after* alloying. Example: To reduce a double eagle (weighing 516 grains, 21.6 carats fine) to 20, 18, and 12-carat plate, divide the weight by 12½, 5, and 1⅓; this gives the amounts of alloy to be added—for the first, 41.3 grains; for the second, 103.2 grains; and for the third, 387 grains.

When it is required to know the fineness of the plate or solder made from known quantities of gold and alloy, *multiply the weight* (W) *of gold, before alloying, by its carat valuation* (C); *divide this product* (CW) *by the weight of the gold after alloying* (W + A); the quotient will be the carat value (c) of the alloyed gold.

This and the preceding rules may be also expressed by algebraic formula:—

$$(1) \qquad A = W \div \frac{c}{C - c}. \qquad\qquad (2) \qquad c = \frac{CW}{W + A}.$$

The fineness of any mixture of alloys of known value may be found by a simple arithmetical rule. Multiply each weight by its carat (pure gold being 24), divide the sum of the products by the sum of the weights, and the quotient will be the carat value of the mass.

The following formulas may be employed for manufacturing gold

plate from pure gold for dental purposes: Nos. 1, 2, and 3 for the base, and No. 4 for clasps:—

No. 1.

Gold Plate 18 *Carats Fine.*

18 dwts., ...	pure gold,
4 dwts., ...	pure copper,
2 dwts., ...	pure silver.

No. 2.

Gold Plate 20 *Carats Fine.*

20 dwts., ...	pure gold,
2 dwts., ...	pure copper,
2 dwts., ...	pure silver.

No. 3.

Gold Plate 21 *Carats Fine.*

21 dwts., ...	pure gold,
2 dwts., ...	pure copper,
1 dwt., ...	pure silver.

No. 4.

Gold Plate 20 *Carats Fine.*

20 dwts., ...	pure gold,
2 dwts., ...	pure copper,
1 dwt., ...	pure silver,
1 dwt., ...	platinum.

The following formulas may be employed for manufacturing gold plate from coin gold: No. 1 for the base and No 2 for clasps:—

No. 1.

Gold Plate 18 *Carats Fine.*

20 dwts., ...	coin gold,
2 dwts., ...	pure copper,
2 dwts., ...	pure silver.

No. 2.

Gold Plate 20 *Carats Fine.*

20 dwts., ...	coin gold,
8 grs., ...	pure copper,
10 grs., ...	pure silver,
20 grs., ...	platinum.

Gold plate 20 carats fine according to formulas No. 4 and No. 2 is suitable for clasps, backings, and irregular appliances where great strength and elasticity are required.

The following formula of Johnson Bros. gives an 18-carat gold plate:—

United States gold coin, ...	64½ dwt ($60)
Pure silver, ...	13 dwt.

CHAPTER VII.

INGOT MOLDS, ROLLING MILLS, SOLDER.

The gold, after being refined or alloyed, should be re-melted in a clean crucible, well rubbed on the inside with borax, and poured into an ingot mold (Figs. 917 A, 917 B) of proper length, width, and thickness.

Ingot molds may be of iron, soapstone, asbestos, charcoal, or car-

bon. The first is perhaps most convenient. The second gives, with the same gold, a tougher ingot; the asbestos ingot block, which may also be used for melting, is a perfect non-conductor, and is represented by Fig. 918; it is 2½ inches wide and ½ inch thick. With the charcoal ingot mold the greatest toughness of metal is obtained, so far as the nature of the ingot-mold can modify it. Pig-iron, from the same furnace, run into molds, may be white and brit-

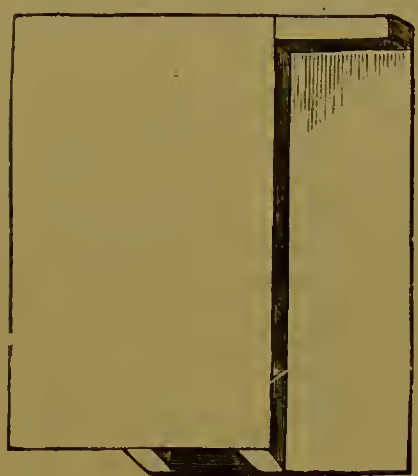


FIG. 917 A.

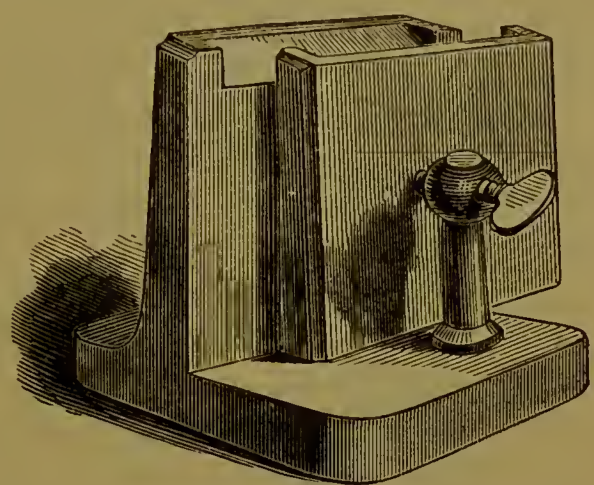


FIG. 917 B.

tle; or into sand molds, gray and less brittle; or into charcoal, dark gray and soft. Some such modification of the molecular arrangement of gold, due to its manner of cooling, is probably the correct explanation of the fact that a charcoal mold yields, other things being equal, a tougher ingot than iron.

An apparatus is now in use which combines the crucible and ingot-

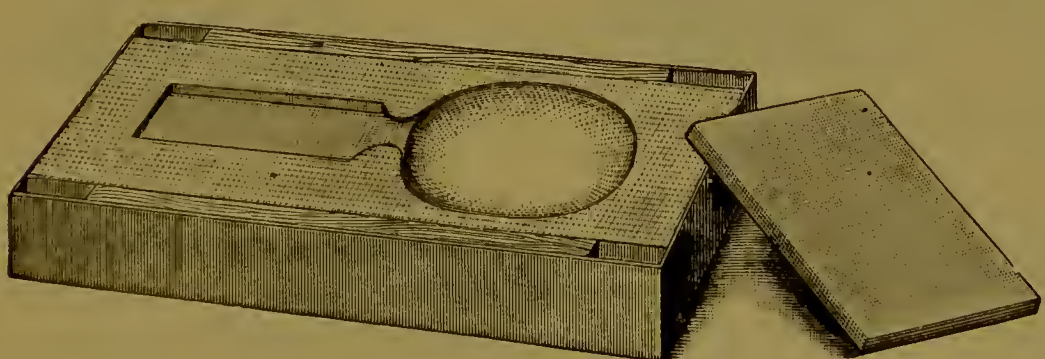


FIG. 918.

mold, in which a crucible, or molded carbon, communicates with an ingot-mold, both held in position by a clamp underneath and swiveling on a cast-iron stand. The metal to be melted is placed in the crucible, and the flame of a blowpipe is directed on it until it is perfectly fused. The waste heat serves to make the ingot-mold hot, and the whole is tilted over by means of an upright handle at the

back of the mold. A sound ingot may be obtained at any time in about two minutes.

The charcoal ingot mold is easily made. Select a fine-grained piece; saw in half and make smooth by rubbing the surfaces together. Then make the matrix in one of three ways: either cut the shape required out of one-half, with the proper gate; or bend a heavy wire into shape of the ingot and gate, and bind it between the surfaces; or saw off a charcoal slab, and after cutting out the shape of the ingot and gate, bind it between the surfaces. Those who have once used a charcoal ingot will seldom use any other.

After the ingot has become sufficiently cool, it may be placed on an anvil, and its thickness reduced to about an eighth of an inch with a hammer weighing from one to one and a half pounds. It should then be well annealed by being placed in the furnace, lightly covered with small pieces of charcoal, and heated until it assumes a uniform cherry-red color; or it may be annealed with a blowpipe. It may be necessary, during the operation of hammering, to subject it once or twice to this process to prevent the gold from cracking. If, notwithstanding this precaution, it should crack, it must be again melted, and refined with muriate of ammonia, etc. Sudden cooling does not make it brittle. On the contrary, some jewelers maintain that if plunged in alcohol and water it is softer than when slowly cooled. A little sulphuric acid in the water will give a bright surface to the plate by cleansing off the oxid of copper; but this acid pickle is only necessary for removal of the metal of the dies used in swaging, or of the borax used in soldering; in all other cases we prefer to have the oxid coating.

After the gold has been reduced to the thickness just mentioned and well annealed, it may be placed between the rolls of the mill, previously so adjusted as to be the same distance apart at both ends, and not so near to each other as to require a great effort to force it between them. The rollers, however, should be brought a little nearer to each other every time the plate is passed between them; and during this process they should be kept well oiled, so that there may be as little friction as possible. Many roll the ingot without any previous hammering. In the process of rolling care must be had to anneal often, and to roll in one direction until sufficient width of plate is obtained; then, before cross-rolling, be sure to anneal, else the plate will be very apt to crack.

Rolling mills for gold are variously constructed. Some are very simple, while others are quite complex, having a great deal of machinery connected with them. The rollers also vary in length from three to five inches. For the gold plate used by dentists, they need

not be more than three or three and a half inches long. Fig. 919 represents a form of rolling mill, with the cog-gearing. It is a strong but simple mill, and is very well suited to the dental laboratory. The set-screws at the top are turned with a rod, and must be both moved alike, else the plate will be thicker on one side, and will curve laterally in rolling.

Fig. 920 represents a more complicated mill. With such a mill, all the heavy rolling of a laboratory could be done without the aid of an assistant.

The thickness of the plate may be determined by a gauge plate. That which is to serve as a basis for artificial teeth for the upper jaw may be reduced until it fits the gauge at 25, 26, or 27, according to the quality of the plate and the depth or irregularity of the arch. For the lower

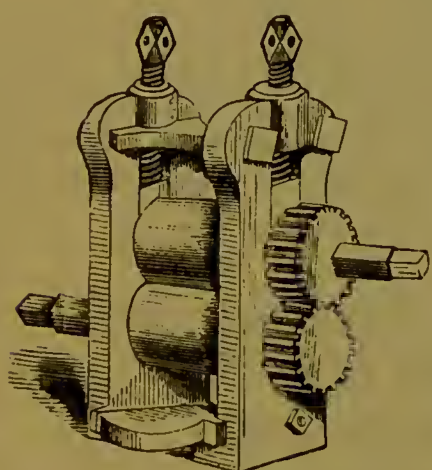


FIG. 919.

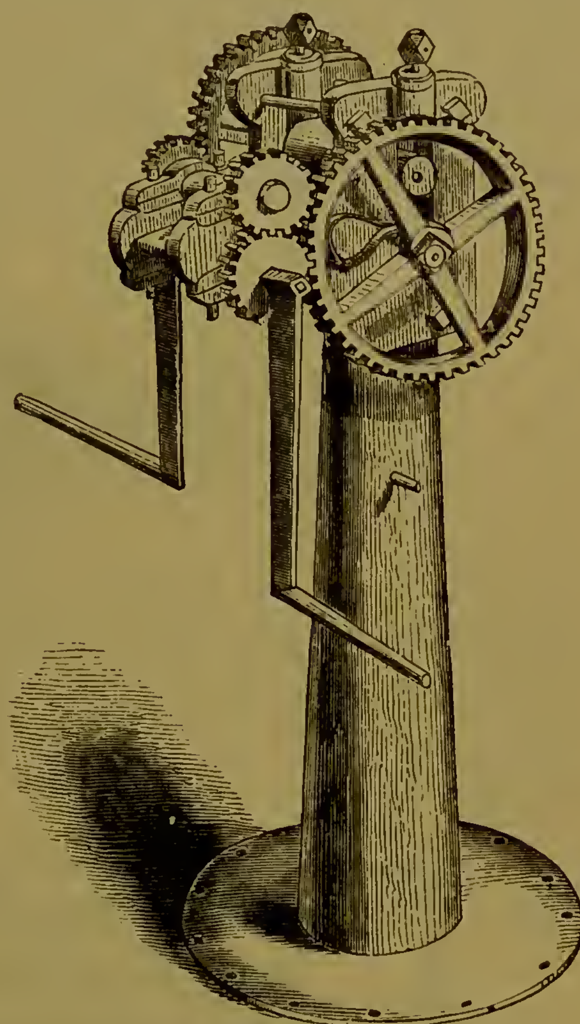


FIG. 920.

jaw, and for backings and clasps, it may range from 21 to 24. When the whole alveolar border and a portion of the roof of the mouth is to be covered, it may be a little thinner than when applied only to a small surface; also thinner when the arch is deep or irregular. The purer the gold is, the thicker must be the plate. When very wide clasps, too, are employed, it is not necessary that the gold should be as thick as is required for narrow ones; and low or wide backings need not be so thick as long or narrow ones. Lower plates, if wired around the edge or doubled over the middle third, may be made of the same thickness as an upper plate. But these are matters which the judgment of the dentist alone can properly determine, and, conse-

quently, no rules can be laid down upon this subject from which it will not sometimes be necessary to deviate.

Gauge plates are, unfortunately, not uniform. For many years the most reliable were those manufactured by Stubbs. But it is difficult

FIG. 921.

to procure them. At the same time it is very important that some standard should be adopted in the profession. Under these circumstances we approve the suggestion of the late Dr. S. S. White, who recommended the gauge plate given in Fig. 921, which has been adopted by the principal brass manufacturers of this country.

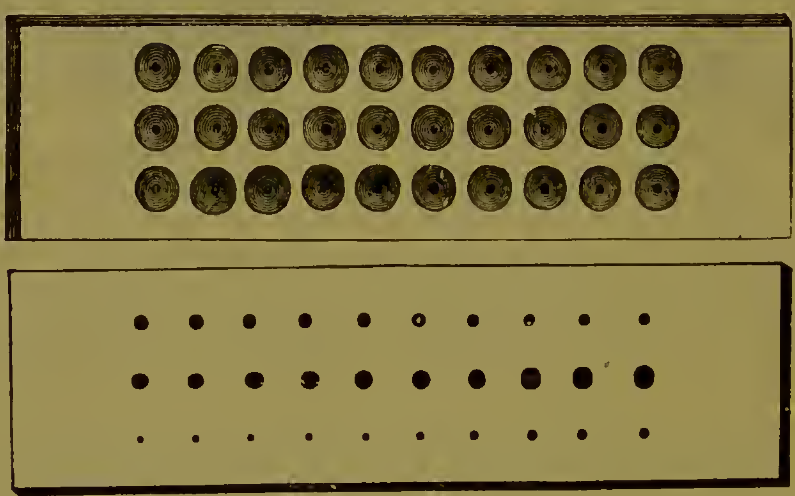


FIG. 922.

It may be necessary sometimes to make gold wire for spiral springs or other purposes, also hollow-tube wire. A draw plate (Fig. 922), strong pliers, and a bench vise (Fig. 923) are the necessary tools for

this purpose. The draw plate should be of the hardest steel, with the holes diminishing very gradually. The pliers should be rough at the end, for grasping the wire, which must be often annealed during the process.

Tube wire may be obtained from the jewelers, by whom it is known as joint wire. But it is seldom over sixteen carats fine. For use in the mouth it should be not less than twenty carats; but for many purposes pure gold or platinum tubing is better. It is easily made as follows: Take a small strip of plate one-fourth of an inch wide, one or two inches long; slightly taper one end; bend it around a mandrel or common knitting needle, and pass it into one of the larger holes of the draw plate. Then with the pliers draw it through and repeat until the edges of the strip meet. Remove the mandrel

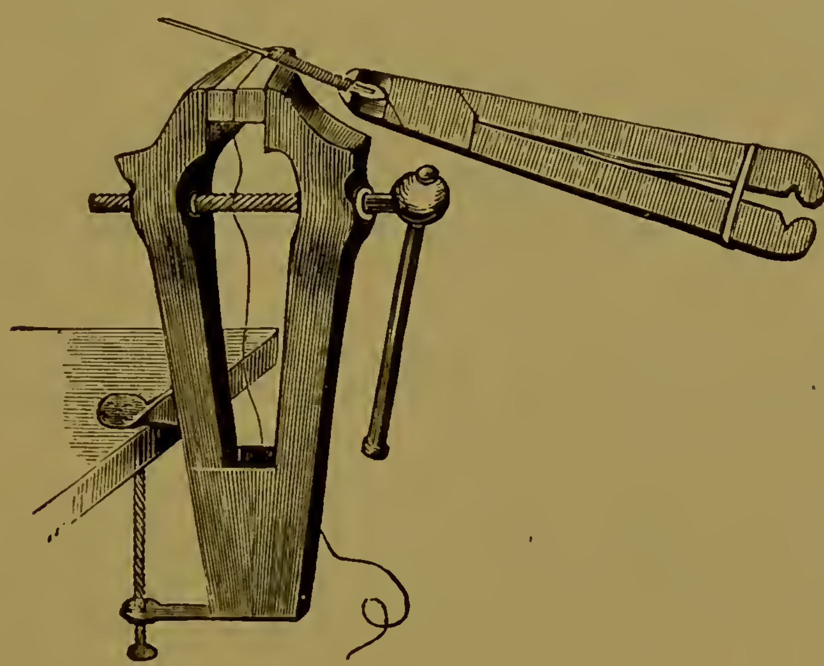


FIG. 923.

and solder the seam with fine gold or else pure gold. Lastly, select a mandrel or needle, the size of the required tube, and draw the wire until it has the proper thickness. If the bore is to be smaller than any needle at hand, the last drawing may be done without the mandrel.

The simplest method of winding wire into a spiral spring is to secure it between two blocks of wood, held between the jaws of a small bench vise, as shown in Fig. 923. The upper end of the wire is then grasped by a hand vise or sliding tongs, in connection with a spindle or steel wire the size of a small knitting needle, six or eight inches in length. The spindle, resting on the blocks of wood, is made to revolve, and by this movement the gold wire is drawn through the blocks and wound firmly and closely round the steel rod.

GOLD SOLDER.

In making gold solder, the materials employed for the purpose, if not pure, should be refined separately. Unless this is done, it will be difficult, and often impossible, to ascertain their relative purity, which should be known to insure the desired result. The gold is placed in a clean crucible with a little borax, and as soon as it has become perfectly melted the silver, and afterward the copper, are added. When all are melted, the alloy may be immediately poured into an ingot mold, previously warmed and oiled. The process of hammering and rolling the solder is the same as that described for gold plate. In consequence of the large amount of alloy in solder, it is sometimes so stiff, and even brittle, as to be with great difficulty rolled; this difficulty is increased by the fact that its low fusibility makes it not very easy to anneal without melting. This is especially the case with solders in which zinc or brass is used.

In making solder into the composition of which zinc enters, the other ingredients must be thoroughly melted, then the zinc (or brass) introduced at the last moment, rapidly stirred, and the metal quickly poured. A piece of charcoal will be found better for making small quantities of solder than a crucible.

The solder employed for uniting the various parts of a piece of dental mechanism should be sufficiently fine to prevent it from being easily acted on by the secretions of the mouth.

If pure gold is used, the solder will be of finer quality than if twenty-two-carat gold is used, but will not flow quite so readily. But twenty-two-carat plate may be used, if its alloy is known, by making due allowance for the amount, which is easily calculated by use of preceding rules. The following makes a solder sixteen carats fine, and may be used for eighteen- or twenty-carat gold plate; it flows very freely:—

No. 1.—	Pure gold,	6 dwts.
	Fine silver,	1 "
	Roset copper,	2 "

By adding one or two grains of zinc, a solder may be made that will flow at a lower temperature than that made by recipe No. 1. It will also have a finer gold color; but it is apt to impart to the piece a brassy taste, and for this reason is objectionable. Zinc solders are apt not only to have a brassy taste, but also to become brittle after long use.

The following formulas will give solder fourteen carats fine; the first from Johnson Bros.:—

No. 1.			No. 2.	
Pure silver,	2½ dwts.		American gold coin,	$10
" copper,	20 grs.		Pure silver,	4 dwts.
" zinc,	35 "		" copper,	2 "

The following formulas from the *American System of Dentistry* are suitable for bridge- and crown-work, and are twenty carats fine:—

No. 1.

American gold coin (21.6 carats fine) $10 piece,	258 grs.
Spelter solder (composed of equal parts of copper and zinc)	20.64 "

No. 2.

Pure gold,	5 dwts.
" copper,	6 grs.
" silver,	12 "
Spelter solder,	6 "

Dr. D. H. Goodno's formula, which is said to give a gold solder which is remarkably tough, flows readily, and does not discolor in the mouth, is composed of the following alloy:—

Pure gold,	40 grs.
" silver,	2½ "
" copper,	2½ "
" zinc,	2

In the melting process the zinc is rolled in gold foil and placed in the crucible and covered with borax. The copper and silver are then added and also covered with borax, and the whole melted. To use this alloy for a twenty-carat plate, 5 dwts. of pure gold are added to 1 dwt. of the alloy; for eighteen-carat plate, 5½ dwts. of pure gold to 1½ dwts. of the alloy.

The following formulas, taken from Dr. Richardson's work on "Mechanical Dentistry," furnish solders (No. 4) over fifteen carats fine, and (No. 5) eighteen carats fine:—

No. 4.			No. 5.	
Gold coin,	6 dwts.		Gold coin,	30 parts.
Silver,	30 grs.		Silver,	4 "
Copper,	20 "		Copper,	1 "
Brass,	10 "		Brass,	1 "

Other recipes might be added, but the foregoing have been found with us to answer every purpose. More difficulty arises in the use of solders from a wrong method of soldering than from defect in the solders themselves. Almost every dentist will be found to have his

favorite recipe, which "invariably flows smoothly." The very fact that so many hundred different solders work so well goes far to prove what we have said. Some will boast of using a solder as fine as the plate. This may be true if by "fineness" we mean simply carat valuation. But a solder containing two grains of zinc to the dwt. is in no true sense as fine as a plate alloyed with that amount of copper; yet both are twenty-two carat metal. Rules for the management of solder, plate, and blowpipe, in the act of soldering, will be hereafter given.

CHAPTER VIII.

CUPS AND MATERIALS FOR IMPRESSIONS OF THE MOUTH—PLASTER MODELS.

In the construction of a dental substitute, mounted upon a plate or base, it is necessary to obtain an exact model of the parts upon which it is to rest and to which it is to be attached. For this purpose a perfect impression of these parts must be obtained, involving—first, the choice of a suitable impression cup or tray; secondly, the selection of an impression material.

IMPRESSION CUPS OR TRAYS

must be of such size and shape as to permit their easy introduction into the mouth; also they must follow, as nearly as possible, the out-

FIG. 924.

FIG. 925.

line of the surfaces to be copied, allowing a uniform space of one-fourth or one-eighth of an inch for the material. These trays are

sometimes called mouth cups; but we think the name given, and now generally used, is greatly to be preferred. They are of two kinds, metallic and gutta-percha.

Metallic trays were formerly made of sheet tin, cut into shape and soldered, and were so imperfect that it was very often necessary to swage metallic trays to suit special cases. The depots now supply an excellent assortment of well-shaped Britannia impression trays, of which sixteen will constitute a full set; namely, six sizes for full upper cases, and three for full lower; three sizes for partial upper cases (in these

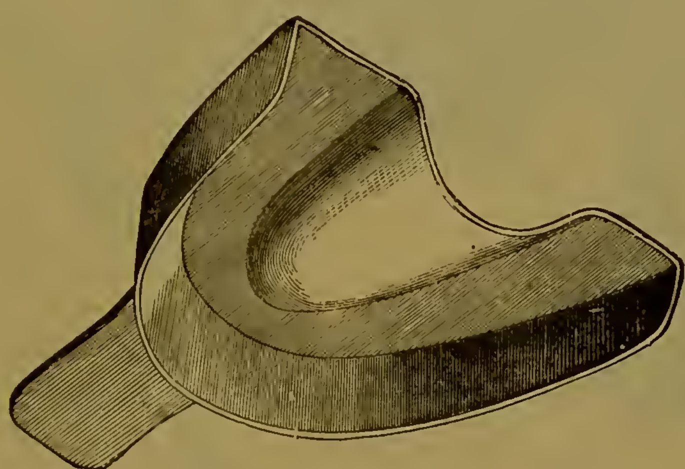


Fig. 926.

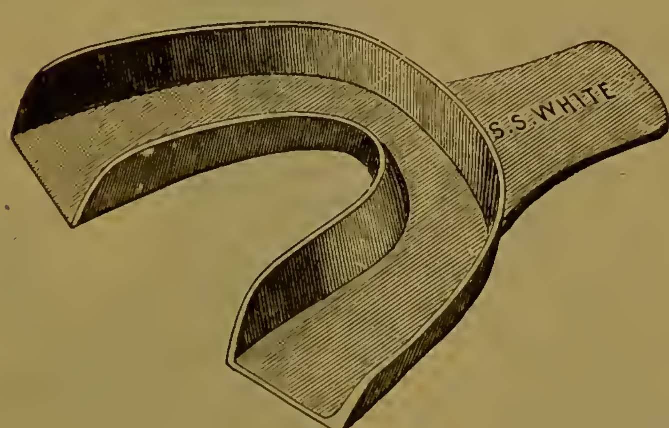


Fig. 927.

the outer rim rises at a right angle), and four for partial lower (these trays have a depression or a place cut out to receive the front teeth).

Figs. 924 and 925 illustrate full upper and lower impression trays.

Figs. 926 and 927 illustrate partial upper and lower impression trays with flat bottom and square sides.

Figs. 928 and 929 illustrate adjustable impression trays. In taking impressions of deep, narrow mouths, or where a masticating tooth standing alone widens the jaw at a particular point, it is sometimes desirable to be able to readily adjust the size and shape of the tray

used. Upper, Fig. 928, and lower, Fig. 929, impression trays have been designed to meet this want. Either of these can be made into a partial tray by cutting off one side.

FIG. 928.

Fig. 930 illustrates Southwick's upper impression tray with raised palatine edges to prevent the plaster from slipping off.

Fig. 931 illustrates a partial lower tray with an opening to allow the front teeth to pass through and the tray to pass down to the maxillary ridge. A piece of wet paper is placed over the opening when the tray is filled with the plaster-batter.

Fig. 932 illustrates Dorr's lower impression tray with posterior lingual wings, which enable the operator to obtain an accurate impression of the jaw on either side of the tongue. These wings may easily be spread apart, or brought toward each other, or twisted, or cut away to adapt the tray to nearly any size or shape of the edentulous lower jaw.

Fig. 933 represents Dr. Franklin's tray for full lower impressions; the slot and upper groove permit secondary pressure of the wax or plaster, after the surplus material is forced up, as it is pressed on the alveolus.

" This tray, or rather double tray, has a groove or space in its center all the way round. The advantages of this groove are, that, when the lower part

FIG. 929.

of the tray is filled, and the upper part one-fourth full of plaster, and placed in position over the ridge, the operator, with the end of the

FIG. 930.

FIG. 931.

finger or other suitable means, can gently agitate the whole mass of plaster in the tray, and thus prevent air-bubbles, blanks, or other im-

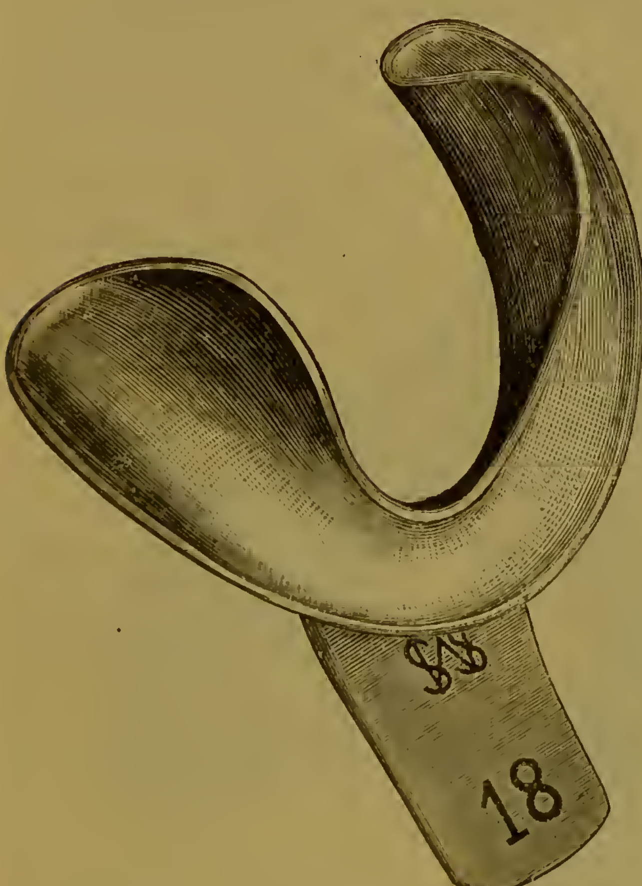


FIG. 932.

FIG. 933.

perfections on the surface of the impressions. The peculiar shape of the outer flanges of this tray is such as to distend the cheeks, while the

lower inner edges, pressing upon the submaxillary and sublingual

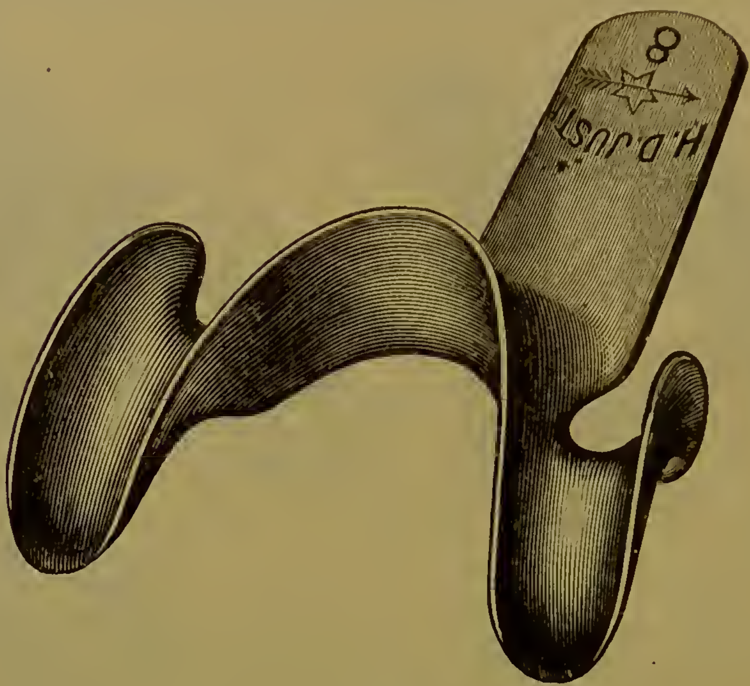


FIG. 934.

glands, depress them sufficiently to prevent any fold or ligamentous attachments from being embraced by the impression.

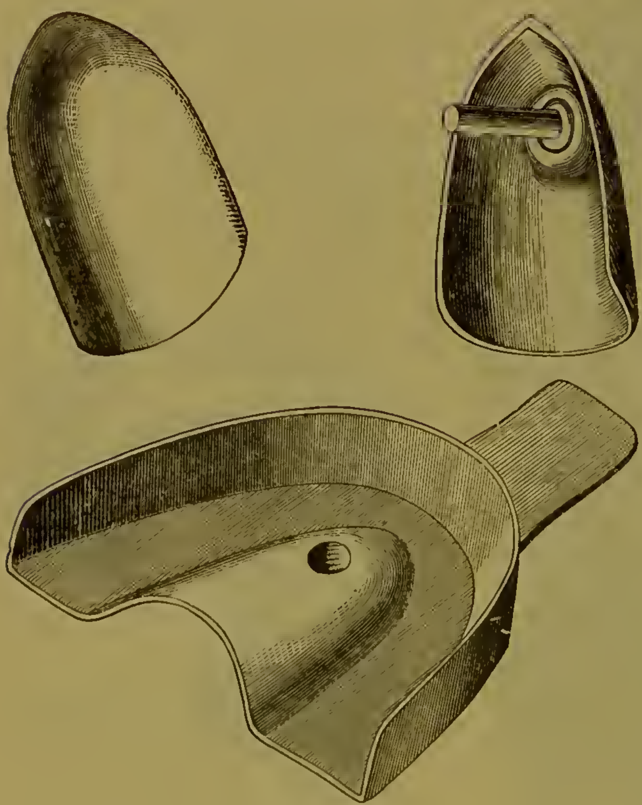


FIG. 935.

Fig. 934 represents a tray for lower molars in partial cases.

Fig. 935 represents the Wardle tray, which is supplied with a movable palate plate, so adjusted that it is capable of forcing the center of the impression material against the highest part of the arch, as well as laterally against the palatal sides of the necks of any remaining teeth.

Fig. 936 represents Fouke's impression tray, by which it is claimed a correct impression in all variety of cases, both partial and full, can be obtained. It consists of a metallic portion with a canvas lining.

The design of the tray suggests of itself the manner of using it; which consists of the ordinary pressure against the metallic part of

A

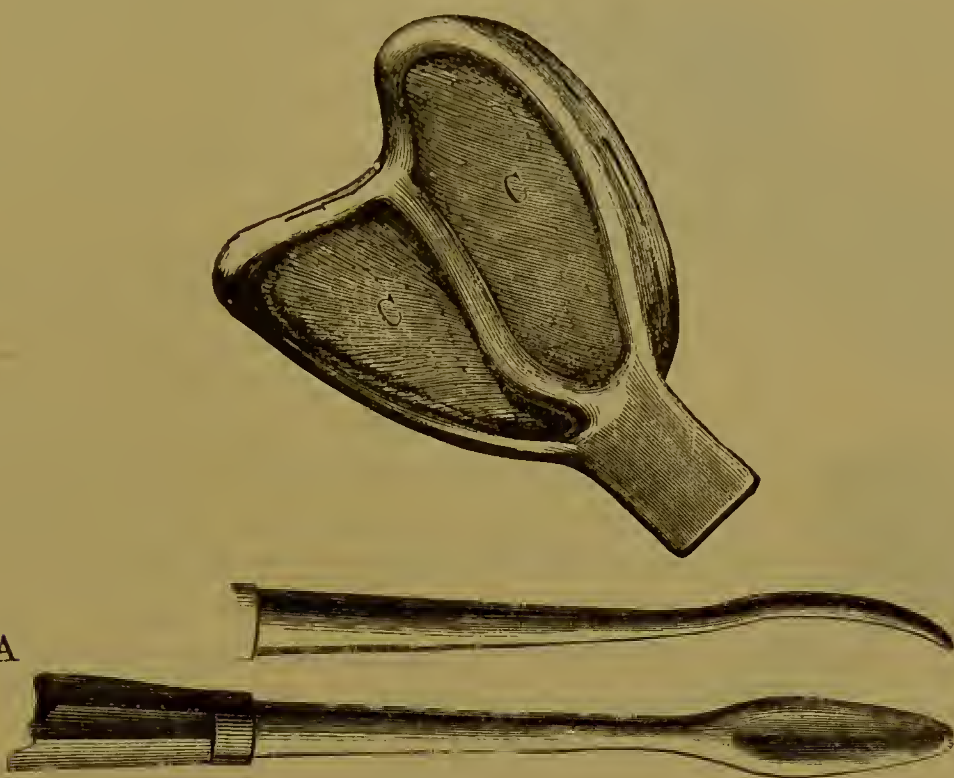


FIG. 936.

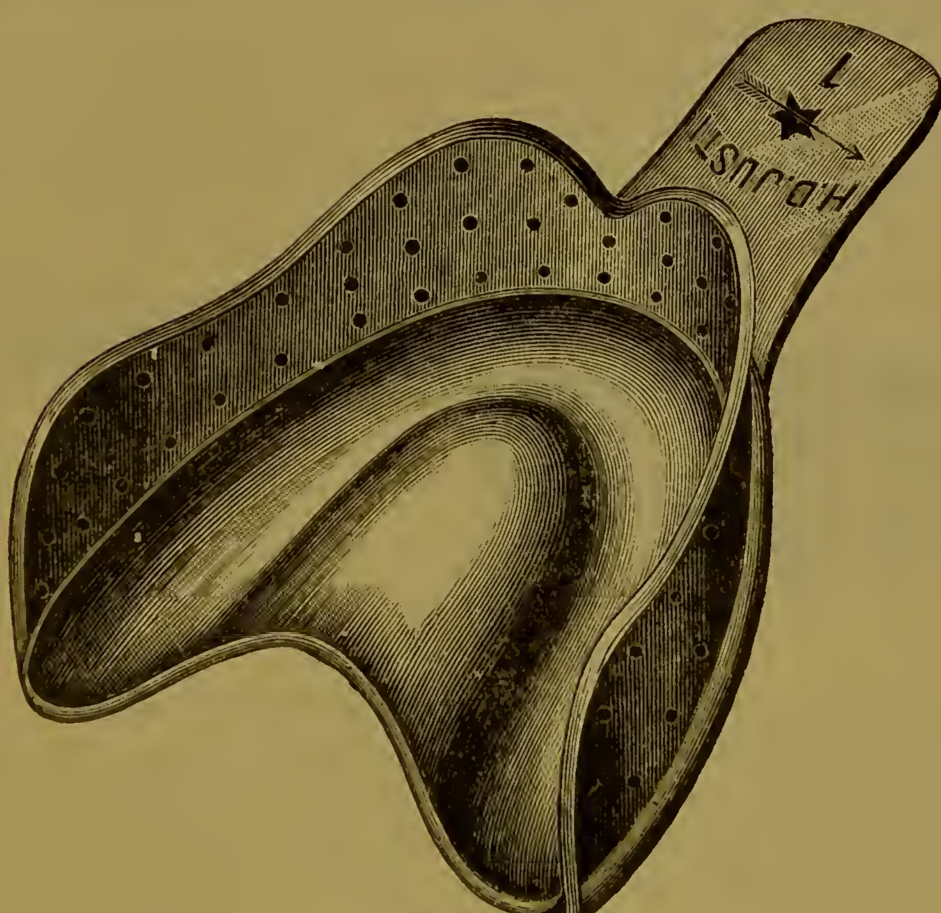


FIG. 937.

the tray, in connection with a proper distribution of pressure with the fingers and compressing instrument A, against the canvas lining of the tray, C C; the latter pressure must be made with a degree of firmness and steadiness sufficient to compress thoroughly all parts of the mouth.

Fig. 937 represents Weirich's flexible rim tray to retain plaster that may break away from outside of ridge, and enable it to be replaced.

Exceptional cases, which no form of purchased tray will suit, may require a swaged brass, zinc, copper, or silver tray; or a tray cast out of Britannia metal, or other tin alloy. The process of swaging will hereafter be described; also, the method of molding a tray from a pattern of wax. Most of these cases, however, may be met by bending, hammering, or cutting the ordinary Britannia tray; remembering always that a wise economy never hesitates to sacrifice the tray to secure excellence of the impression or the saving of time. Without this adaptation of the tray to the form of the alveolar ridge and palate it is impossible, in certain mouths, to get a good wax or gutta-percha impression. Fig. 938 illustrates a partial upper tray for one or two teeth, which is useful in pivoting and bridge-work.

FIG. 938.

Figs. 939 and 940 illustrate partial upper or lower trays.

Trays similar in shape to the Britannia, but not in so many varieties of size, are also made of hard rubber and porcelain. The first cannot easily, and the latter cannot at all, be modified in shape to suit special

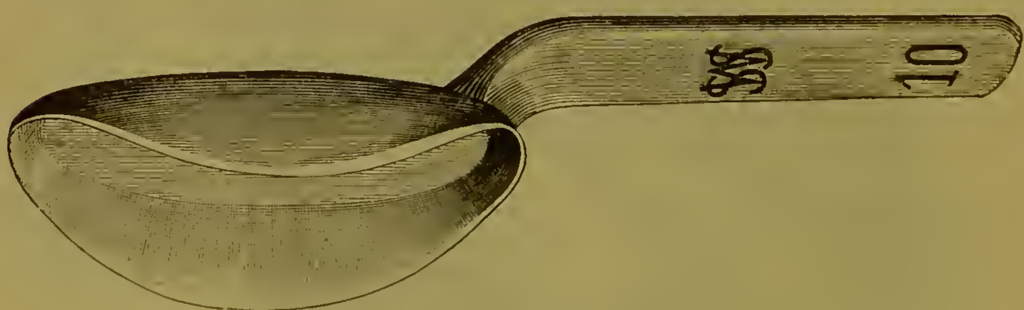


FIG. 939.

cases. The porcelain trays are handsome and clean looking, but they are easily broken; and when plaster is used, it will sometimes leave the glazed surface and cling to the mouth. We, therefore, prefer the Britannia tray, unless the case requires Prof. Austen's gutta-percha tray.

These trays were originally devised to meet a difficulty incident to

vulcanite partial pieces. Perfect impressions of dove-tailed inter-dental spaces, and the lingual side of molars and bicuspids, often undercut, are impossible in wax or gutta-percha. Yet Prof. A. regarded this as essential to the proper construction of a partial vulcanite set of teeth.

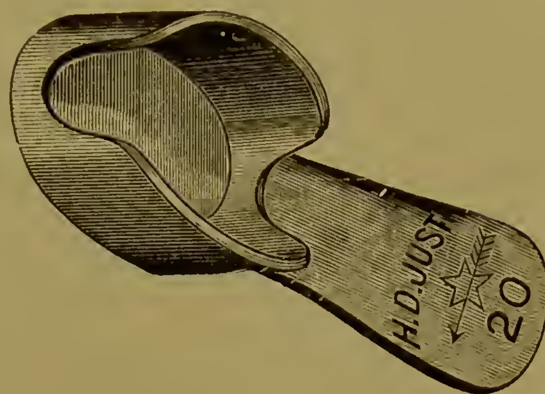


FIG. 940.

They are thus made: Take a wax impression and make a model; in partial cases, brush over the teeth of the model one or two layers of thin plaster, to fill up all undercuts, and to make the plate fit loosely; saturate the model with water, and mold over it a gutta-percha tray. This last is done, not by using the gutta-percha in sheet, but by first making into a ball; then working it from the palate outward, leaving a thick mass in the center. It should be, on the inside, from one-fourth to one-half of an inch thick, so as to be stiff and unyielding; but on the outside not more than one-eighth or one-sixteenth thick, so as to be slightly elastic and yielding. The whole inside of the tray must be roughened up with a scaler or excavator in such a way that the plaster can take firm hold. In most partial cases, the impression will have to be removed in sections; the inside remaining entire, but the outside and the parts between the teeth coming away separately. In certain cases it is necessary to partially cut through the tray before putting in the plaster, and usually upon the thick masses of gum which fill the interdental spaces. A cut on the inside, in line with the ridge, gives pliancy to an otherwise rigid tray, and permits its easy removal. When it is desirable to extend the tray around the entire arch, so as to get an exact plaster impression, not only of the gum but of all the remaining teeth, this rim of gutta-percha must be slit at two or three points, to give that pliancy which is a chief merit in this form of tray. These trays have no handle, but are removed by inserting a plugging instrument into a small hole previously made in the back part of the tray, where it is thickest.

IMPRESSION MATERIALS

Must possess the following properties: (1) Plasticity in sufficient degree to copy mucous tissues, avoiding the extremes of softness, which permits them to flow from the tray, and of hardness, which requires excessive pressure. (2) The property of hardening within a short time, and under conditions not incompatible with the mouth. (3) Absence of expansion or contraction, except in very moderate

degree. It may also be added that the materials should not be such as, in taste, smell, or appearance, are calculated to disgust the patient.

There are four materials answering to these requirements, and possessing properties as distinctive as the sources whence they are derived. From the Animal kingdom, Beeswax; from the Vegetable kingdom, Gutta-Percha and Modeling Composition; from the Mineral kingdom, Plaster. After their separate description, a brief review of their distinctive properties will be given. No one of the four can be dispensed with; no one should be exclusively used.

Beeswax.—Formerly the only material used, and is yet very useful for certain cases, and is absolutely indispensable for other dental purposes. The best wax is from virgin combs, and has a rich golden color. Commercial adulterations with tallow, etc., injure it, and mixture with resin makes it harsh and difficult to manage. Gutta-percha is sometimes incorporated with it to give hardness in warm weather; bleached or white wax is also used for the same purpose.

A very valuable addition is paraffine. Pure paraffine is very plastic, softening at a low temperature (100°); but the folds of soft paraffine have no tendency to reunite, and consequently the mass is full of easily separated flakes or layers. It imparts this property to wax, if in too large proportion; but its moderate use greatly improves the wax. It causes it to soften at lower heat, makes it more plastic when warm, and harder when cool.

The depots furnish wax and its compounds in very pure, neat, and convenient forms; so that there is now little necessity for the dentist to spend the time once demanded to reduce the thick cakes into serviceable shape. It may be well, however, to state briefly how to prepare wax for impressions. Melt and pour into cakes one-quarter of an inch thick; cut into pieces about two inches square; and when nearly cold roll on a wet board, with a wet wooden roller, to one-half or one fourth this thickness. This breaks down the crystallization, and reduces it to a form very convenient for softening when wanted for use. It may be softened over a broad flame, or before a fire or stove, or in warm water. In using dry heat be careful not to melt the surface, or give the peculiar whitish appearance that precedes melting. In using water, have a large quantity, to secure uniformity of temperature, and keep it at 120°–130° Fahrenheit. Below this it will not yield readily to the gum; above this it becomes adhesive.

Some practice is necessary in knowing the proper quantity of wax to use in the tray; the usual mistake is to take too much. Select a tray of proper shape and size; if the arch is a deep one, put some hard wax or gutta-percha in the center to force up the wax at that point. This is much better than to have a hole in the tray through

which to make pressure with the finger. Such trays are worse than useless, for it is impossible to make secondary pressure without injury to other parts of the impression, except in case of wax projecting above the tray, outside the ridge. Put the wax in the tray; smooth the surface, which should be a little softer than the body of the wax; then introduce and press against the gums or teeth with a steady, uniform, and moderately strong pressure; also, as nearly as possible, in a direction at right angles to the plane of the alveolar ridge.

The wax above the tray is pressed against the gums on each side, so that an exact impression may be obtained of all the depressions and prominences on the outside of the arch. But this must be done with great care, holding the tray firmly and pressing the finger against the cheek or lip, rather than directly upon the wax. It is much better in all cases to have the sides of the tray high enough to give the wax support at all points. For this purpose, it becomes necessary sometimes to swage or cast a special tray. Very perfect wax impressions can be taken in such trays. On the removal of the trays and wax from the mouth, the greatest precaution is necessary to prevent injuring or altering the shape of the impression. Holding the handle firmly, it must be drawn directly downward, in case there are front teeth, in the direction of the axes of these teeth. Impressions of a full upper arch sometimes adhere very tightly. They can generally be loosened by drawing up the cheek and lip on one side or both sides alternately; or by a slight cough, which, acting upon the palate, admits air behind and above the impression. Any violence or twisting motion injures the impression; in wax or gutta-percha such defects cannot be detected until, on completion of the plate, maladjustment creates suspicion of its cause. The wax must be kept in the mouth long enough to cool and harden. A small piece of ice in a napkin, held against the under side of the tray, will rapidly harden it. This simple plan is preferable to the use of double trays, into which a stream of cold water is injected. The latter are not only expensive and troublesome to use, but they endanger the accuracy of the impression. All wax impressions, unless for models on which other trays are to be made, should be hardened by artificial cold; it greatly helps to prevent change of shape on withdrawal. If the surplus wax, by contact with the lips or teeth, injures the impression, then, if it is a full case, cut off the surplus, dip into warm water, and introduce the same impression a second time; but if it is a partial case, it must be taken anew, for the teeth cannot, with any accuracy, enter their wax impressions.

Gutta-Percha.—This very valuable material will be found useful in taking impressions of the lower jaw and in some partial cases, also

frequently in full upper cases where the teeth are set on a vulcanite base. The manipulations are different, accordingly as we wish to make the gutta-percha adhere to the tray, or wish it to part from the sides of the tray as it shrinks on cooling. In the first case, soften in water heated to 180°–200° Fahrenheit; dry off the water; hold for a few moments over a flame, and press into a warm tray; keep the fingers wet, to prevent the gutta-percha from sticking, but do not let water get between it and the tray. In the second case, keep the surface of the gum wet, and introduce it into a cold and wet tray. When the tray is filled, place again in water at 180°; then press it somewhat into shape, and introduce into the mouth. Pressure must be more gentle than for wax; it must be kept longer in the mouth, and ice should be used to cool it. Be very careful, in partial cases where there is much undercut or a dovetail space between teeth, not to make the gutta-percha too hard, else it will be almost impossible to get it out of the mouth.

Gutta-percha copies surfaces with all the accuracy of plaster, but, although harder than wax, it is more apt than plaster to change its shape upon withdrawing it from the mouth. Its characteristic peculiarity is contraction on cooling; but this is controlled, when required, by the directions above given for making it adhere to the tray. It is less easily manipulated than wax, and not so generally useful; but its property of contraction admirably adapts it to certain cases in which plates, otherwise accurate, fail, because too large and loose.

Gutta-percha for impressions is supplied in convenient form by the depots. The native color is dark, and calculated to repel fastidious patients. For this reason, also to give it body, it is incorporated with about its own weight of white oxid of zinc, magnesia, or chalk, and a pinkish color given by vermilion. Thus prepared, it is less sticky when softened, and becomes harder, when cool, than the crude article.

Modeling Composition or Compound is composed of gum dammar, stearine, French chalk, with carmine to color it, and a perfume to render it pleasant. Four varieties are manufactured—the soft, the medium, the hard, and the extra soft, differing as to the quantity of stearine and chalk incorporated with the gum. Modeling composition is an excellent material for impressions, as it copies very accurately and affords a smooth model. The best manner of using it is to soften this material in boiling water contained in a shallow vessel. When it is thoroughly softened, and not too hot to handle, the tray for its reception should be slightly warmed, into which, after drying with a cloth, it is introduced in the same manner as wax. After it is

applied to the mouth, it is allowed to cool somewhat, after being pressed around the outside of the alveolar ridge.

The same care is necessary in removing it from the mouth as with wax, and it should be immersed in cold water at once, to harden it. Before pouring the plaster the impression should be dipped in cold water. To remove an impression of this material from the plaster model, both are immersed in boiling water, where they should remain until the compound becomes soft, but not adhesive, when it is easily separated from the model.

Plaster—*Gypsum, Sulphate of Lime,* or *Plaster-of-Paris*—consists of 28 parts lime, 40 of sulphuric acid, and 18 of water; the first its mineralogical name, the second its chemical, the third its commercial. A beautiful translucent variety of gypsum is known as *alabaster;* the transparent crystalline variety is called *selenite.* That, however, used in agriculture and for calcining is in amorphous masses of a grayish or bluish-white color. When exposed to a heat between 300° and 400° Fahrenheit, most of the water of the gypsum escapes. It is then known as calcined plaster, plaster-of-Paris, or simply plaster. After being properly calcined and pulverized, if mixed with water to the consistence of thin batter or cream, it hardens in a few minutes, and acquires great solidity. The plaster has chemically reunited with a portion of the water, while another portion is mechanically held in the porous mass, and may be driven off by drying. During the process of consolidation it expands, in consequence of the absorption of the water by the particles of plaster. If the plaster is very fine-grained, this absorption takes place quickly, and the expansion occurs while the plaster is soft. But coarse-grained plaster sets before the particles become thoroughly saturated; hence it continues to expand, more or less, for some time after solidification. There is a great difference in the quality of plaster. That used for taking impressions of the mouth (and, in fact, for all dental purposes) should be of the best description, well calcined, finely pulverized, and passed through a sieve of bolting cloth previous to being used. The idea of taking impressions for full sets of teeth with plaster originated, we believe, almost simultaneously with Drs. Westcott, Dunning, and Bridges, by whom and the profession generally it was regarded as adapted almost exclusively to full impressions. Prof. Austen, however, introduced a method of using it in connection with gutta-percha trays, which makes it, in the hands of a careful manipulator, universally applicable to every case in which a dental appliance is called for. He would, however, by no means recommend such universal application, claiming only that the gutta-percha tray will give with plaster a correct impression of partial cases of greatest irregularity, where the use of wax or gutta-percha would be

impossible. A composition of plaster-of-Paris, white sand, sulphate of potash, and Venetian red, a formula suggested by Dr. Teague, forms an excellent impression material.

For plaster impressions in ordinary full cases, upper and lower, select a Britannia tray, about one-eighth of an inch larger than the alveolar ridge, and, in case of a deep upper arch, build up with wax, so as to give support to the soft plaster; also supply with wax any deficiency in the size of the tray at the back part or around the outside edge. In exceptional cases requiring a special tray, a gutta-percha one will be found to be much easier made than a swaged or cast metallic tray. If properly shaped, it will fully answer the purpose.

The late Dr. J. B. Bean's practice was to take a wax impression, make model and dies, and swage a plate; then solder a strip from ridge to ridge, to hold a stick, which was to act as a handle in removing the impression. He then heated the plate, and coated the palatine surface with shellac, pressing a lump of raw cotton against the adhesive resin. The cotton fibers caused the plaster to adhere firmly to the plate, thus avoiding the great annoyance when scales of plaster, so thin as in this kind of tray, break off. The process is troublesome, but the results are very satisfactory.

To take a plaster impression, place a patient in a common chair, and after the tray is introduced, incline the head forward, holding it in place with a gentle but steady pressure upon the center of the tray. The plaster should be very fine-grained and mixed rather thin, to get rid of air bubbles. If necessary, a little salt or a few grains of sulphate of potash should be added, to quicken slow-setting plaster. The necessity for salt and quantity to be used should not be left to conjecture; hence the importance of setting aside in a well-closed vessel a quantity of "impression plaster." Also, if the plaster is "slow," set aside a large bottle of salt water of the exact strength required to make the plaster set properly. There will, in this way, be no danger of the plaster setting too quickly or too slowly. If made to set too rapidly, it hurries the operator and increases the risk of failure; if it sets too slowly, both patient and operator become wearied before it is hard enough to remove. Tepid water promotes the setting of plaster. It should require about three minutes to harden after it is introduced into the mouth, which must be done when it is stiff enough to allow the plaster to be molded into some shape, and yet soft enough to permit no sharp points or angles on its surface. If softer than this, the slightest pressure forces it out of the tray to run sometimes out of the mouth, sometimes on the tongue and fauces. This also is apt to occur if an excess of plaster is used. These unnecessary accidents are well calculated to prejudice patients against plaster, and, perhaps, against the operator.

The hardness of plaster in the mouth can be ascertained by the watch, when the exact time required for setting is known, or by testing some of the plaster remaining in the bowl. As soon as it breaks with a sharp fracture, it should be removed. To keep it in much longer than this is apt to give unnecessary pain and difficulty in removal, owing to the absorbing property of the hardened plaster, which causes it to cling with great tenacity to the mucous membrane.

Full lower impressions are generally easy to withdraw ; but some full upper ones adhere very tenaciously. Raising the cheek on one side or in front, and depressing the tray, will detach most cases. This can be done, in case of plaster, without risk of injuring the shape of the impression. If this does not loosen it the patient may be requested to give a slight cough. Where there is much undercut, the plaster will break ; but it can readily be replaced. Sometimes the action of the cheeks and lips, or of the soft palate, will loosen the impression ; or an instrument may be used to press up the palate, and thus cause air to pass in at the back, when it may be easily removed. Complicated modifications of the tray to facilitate removal are of little value, and make an unnecessary multiplicity of apparatus.

In partial cases, the outer rim (which for this purpose is made elastic, or else in sections) is first detached, and the central portion then loosened by an instrument inserted into the *back* part of the gutta-percha cap. If there should be many broken, detached fragments, either loose or caught in dovetail spaces between the teeth, these must be very carefully removed ; and when the surface moisture has dried off, they must, with the utmost nicety, be replaced in the impression. This is sometimes a tedious and difficult operation ; but it is not trouble misapplied, since it is the *only* way in which perfect impressions of difficult partial cases can be obtained. Should the detached plaster be from a very irregular surface, its readjustment is made much easier by touching the gutta-percha at that point with a camel's-hair brush dipped in very hot water. The fragments being all adjusted and the outside ones secured by a little resinous cement, should there be much broken surface on the inside, it is best to varnish heavily with sandarach to cement the pieces ; otherwise, let the surface be prepared, as in full sets, for preventing the plaster of the model from adhering.

Wax and gutta-percha require nothing for this purpose, or, at most, a very thin layer of oil. Plaster impressions may be rendered separable : 1, by an alcoholic varnish of sandarach or shellac, or a diluted solution of soluble glass, with a little oil upon the varnished surface when dry ; 2, by saturating it with as much oil as it will take up without standing upon its surface ; 3, by coating the surface with a dilute soap mixture. The varnish may be either transparent or colored ; the

transparent varnish consists of gum sandarach, ℥v; alcohol, Oij; the colored varnish consists of the same proportions of gum shellac and alcohol. The gum is added to the alcohol and digested over a moderate heat until it is dissolved. The varnish is best applied with a small bristle brush; the oil and soap water with a camel's-hair brush or a stiff, pointed feather. The varnish must be kept well stopped, or from time to time diluted, so as not to become thick. The soap mixture needs, occasionally, renewal, as the plaster gradually neutralizes its oil and renders it unfit for use.

Some dentists take plaster impressions, in certain cases, thus: First, a wax impression, as usual; then enlarge, by pressure, or by cutting out the depressions formed by teeth or a prominent alveolar ridge; lastly, they pour in a thin layer of plaster, and repeat the impression. Others surround certain teeth with a collar of wax, preparatory to taking a plaster impression.

The last is a troublesome method, very apt to fail, from the slipping of the wax collars; nor has it any superiority over a wax impression, to compensate the trouble. Dr. C. J. Essig suggests the following method for securing a plastic impression for partial cases: "An impression should first be selected of the proper size and shape; those with the flat floor are best for partial cases; the plaster should be mixed thin, almost as thin as water, adding chlorid of soda to facilitate setting. Plaster mixed in this manner does not become hard and unyielding as that mixed merely to saturation. Now oil the tray so that it will readily separate from the impression when hard, fill the tray as soon as the plaster thickens sufficiently, then, with a small spatula, place a layer of the soft plaster in upon the palatine surface; otherwise by enclosing the air in the deep portion of the arch the accuracy of the impression may be impaired. After this precaution the tray is placed in the mouth, and gently pressed up until its floor comes in contact with the teeth. When the plaster is sufficiently hardened, remove the tray, which, from its having been oiled, is done without difficulty; with the thumb and index finger break off the outside walls; the portion covering the palatine surface is then removed by the use of a blunt steel spatula, curved at the end in the form of a hook. The pieces are then placed back into the tray, where they will be found to articulate with perfect accuracy. Should the first attempt be rendered futile, by the tendency to nausea or troublesome gagging on the part of the patient, camphor water, as recommended by Dr. Louis Jack, may be used as a gargle, which will, in nearly every case, prove an effectual remedy."

The comparative value of the four impression materials—wax, gutta-percha, modeling composition, plaster—can only be determined by a

careful study of (1) their distinctive peculiarities; (2) the special requirements of different mouths; (3) the kind of base-plate and manner of its construction. The exclusive use of one is as reprehensible as the indiscriminate use of all. No one is best, nor can any be dispensed with. Disregard of this most important fact is a fruitful source of failure in impressions; failures arising neither from defect in the material nor lack of skillful manipulation in the operator, but from want of philosophical selection of resources.

(1) *Wax* demands strong pressure and is inelastic; also, it neither expands nor contracts on cooling. It copies a hard gum accurately, although it never gives the fine tracery of gutta-percha, modeling composition, or plaster. It also copies a soft gum, but not until the gum is either compressed or thrown out of shape by the strong pressure required. *Gutta-percha* requires moderate pressure; is slightly elastic; also has, as its marked peculiarity, very decided contraction on cooling, which, however, is under control, as previously explained. Slight undercuts it will take, without dragging, as wax does; but, on the other hand, it will occasionally pass into very narrow interdental spaces and injure the impression in the effort to withdraw therefrom. *Modeling Composition* ranks next to plaster as an impression material, and when thoroughly softened in boiling water, and when not too hot to handle, will give an accurate impression under strong pressure and a much finer tracery than wax. *Plaster* permits only gentle pressure, taking impressions of softest tissues in natural position. It slightly expands in setting; but, in a rigid tray, this makes no appreciable increase in the size of the model. It sets so hard that it will break before leaving the smallest undercut; but, by virtue of the same quality, it can be used in the most marked cases of dovetail, or alveolar undercut.

(2) Alveolar and palatine surfaces, and their investing membranes, have a great variety of conditions. These must be carefully examined with reference to the properties, just named, of the impression materials. We have large or small arches; deep or flat ones; irregular or smooth ridges. The mucous surfaces may be uniformly hard or soft; the ridge hard and palate soft; or the more difficult combination of soft ridge and hard palate; or the ridge may be irregularly hard and soft. No one material can possibly be equal to these varying conditions.

(3) The mode of constructing the plate will often determine the choice of an impression material. A plate swaged upon a zinc die is smaller by the shrinkage of the die. Here—apart from shape or hardness of the parts—plaster would be best, wax next, gutta-percha the worst. A vulcanite plate is larger than the mouth, by the expansion of the model. Here, the contraction of gutta-percha will often prove a

very valuable compensation; also the compression of tissue made by the pressure of wax; special considerations must determine which of these to choose. Plaster is the most reliable impression material as a general rule, and is the only material in difficult cases worthy of any reliance. It may safely be asserted that the operator who cannot take an accurate plaster impression of any partial case, however difficult, has a very imperfect idea of the value of hard rubber. For the majority of partial cases, where swaged work is used, modeling composition, or wax, if properly manipulated, will give ample accuracy. Where, however, the undercut, and consequent dragging of wax, is very great, plaster must be employed.

Large, or hard, or irregular mouths are best copied in plaster, great deviations from normal size or shape requiring special trays. A gum of medium softness, but uniform, may be taken equally well in any material. This class of mouths have a wonderful adaptation to anything. Variations in size or form must determine the selection of the material. A gum of extreme softness, yet uniform, will give better results sometimes with one material, sometimes with another. It is often very difficult to determine beforehand; but, in case of failure, let the second impression be taken always with a different material. This is especially true of lower sets, where the gum behind is soft and flexible; it is hard to say whether the pressure of wax, or modeling composition, or the softness of plaster leaves the ridge in best condition; gutta-percha is often very useful in these cases.

Irregularity of texture in the mucous tissues is a fruitful source of trouble. A hard ridge, with a soft palatine surface, is easily fitted, and any impression material may be used. But the reverse condition will often require the firm pressure of wax or modeling composition upon the ridge; also in all cases of inequality of texture in the ridge itself. As a rule, subject to exceptions, a harder impression material than plaster is the best for these mouths, and occasionally (especially for vulcanite) the contraction of gutta-percha is useful; and scraping the model for a vulcanite plate, and building on a thin film of wax for a metal plate over the hard portions, is often serviceable in securing adaptation. For vulcanite plates, the model may be scraped slightly on either side of the hard palatal center.

For metal plates, a thin film of wax, about $\frac{1}{16}$ of an inch in thickness, is built along the entire hard palate, terminating in thin edges, the space to be thus covered varying according to the width of the mouth. The model should also be slightly scraped at the posterior edge of the surface to be thus covered by the plate on each side of the hard portion of the palate, so that the plate may be closely adapted at such points.

It is evident that an enumeration of all the complications which call for exercise of judgment in the selection of impression materials is impossible. By suggesting a few varieties, we hope to direct attention to a much neglected point, in our judgment of utmost importance. Routine practice, which inquires into the reason of nothing, and the one-idea system, with its "practice makes perfect" motto, are equally at fault. The future may reveal some new material; but the four we now have are alike important and indispensable.

PLASTER MODELS.

The model is made of calcined plaster, mixed with water so as to have the consistence of cream, too much water making the model fragile, whilst too little will prevent the escape of the air contained in the plaster, and the model will be porous. This last condition also greatly endangers the full flowing of the plaster into the inequalities of the impression.

The model, for convenience of description, is said to have a face, back, body, and sides—terms scarcely requiring explanation. The face, corresponding with the mouth to be fitted, requires greatest care; and the same directions answer for it in all models. The body of the model has different shape and size according to the use to be made of it. The back should be, in all cases, parallel with the face. The sides are to be either vertical or slanting, according to its uses.

In making models, we require a plaster table, with a rim to prevent scattering of waste plaster, having at least two drawers in front, a shelf at the back, also an opening for escape of waste plaster into a refuse box; a tight plaster-can and a bucket of water will complete the outfit of the table. The implements are two or three strong bowls, a plaster scoop, a spatula, an iron spoon, a plaster knife, a scraper, a sponge, and some camel's-hair brushes or wing-feathers of poultry. Sometimes a marble slab or slate is used for shaping the back of the model upon; but if the table is kept clean and smooth with the scraper, this is not essential; since, in any case, a piece of wet paper should be laid down to permit the ready removal of the model, for the purpose of shaping, whilst yet rather soft.

The most troublesome models are the thick ones for sand molding. The surface of the impression being prepared as above directed, the tray is surrounded with a rim of wax, waxed cloth, sheet lead, or tin foil, fitting closely, to prevent escape of plaster, and about two inches deep. The rims should be slightly curved, to give, when placed around the trays the requisite flare. Models made in such rims need trimming with the knife. To avoid this, and also to give greatest possible smoothness and regularity to the sides, flaring rings of sheet

tin may be used as follows: Set the impression level on the table, and surround with some soft, plastic material, such as potter's clay (wet newspaper made into a pulpy mass is perhaps the most convenient), and into this set a ring of such size as will give a proper shoulder to the model. Fig. 941 shows such a ring arranged for making such a model for plastic work, such as vulcanizable rubber, the models for which need not be very deep. For a sand model the ring should flare, should conform more to the shape of the tray, and be smaller. For the dipping process of making counter-dies and dies, the model needs no specially nice trimming. For the fusible-metal process, the model should be cylindrical and not flaring. These are the three forms of thick or deep models.

The shallow models are usually made without rims. The impression

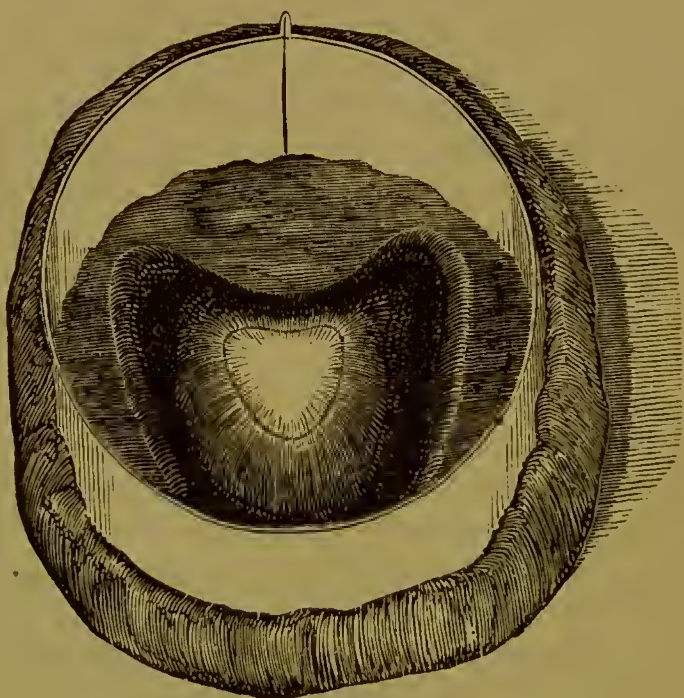


FIG. 941.

is filled, then turned down, when the plaster has set sufficiently to permit it, on the remaining plaster, which has been poured on a strip of wet paper placed on a smooth, flat surface. Whilst plastic it is shaped with the spatula. If for vulcanite or other plastic work, it may be taken up while soft enough to dress with a sponge. But if the shallow model is to be used in sand molding or in Dr. Gunning's process, it is allowed to harden and is then trimmed with the knife. In vulcanite models it will save time and insure greater accuracy in articulation to extend the model at once and make the articulating portion, if no metallic articulating frame is to be employed, as will be fully explained when describing the process of articulation. The sides of vulcanite

models need no shaping except such as neatness and convenience in handling require, since they are subsequently set into the flask; but they should be no larger or thicker than strength requires.

When rims are used, the impression should rest upon the plaster table; if set level, the back will necessarily be parallel with the face, since the thin plaster poured into the rim finds its level. In making shallow models the impression is held in the hand, thus permitting the flow of the plaster to be aided by moving or tapping it. As before stated, wax or gutta-percha needs no oiling; plaster may be oiled or soaped, or else varnished and oiled; it must also be saturated with water just before pouring the model.

Calcined plaster for models should not set too rapidly, as this will cause haste with its attendant dangers. Coarse plaster makes a stronger model, but it has greater expansion. Gum-water, or size, retards the setting, but makes the model very hard; salt quickens the setting, but should not be used for any models which are to be kept

FIG. 942.

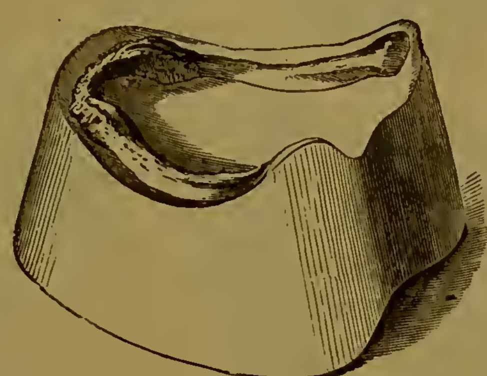


FIG. 943.

as permanent records of the case. It is better to add the plaster to the water than the reverse; it makes smoother work by permitting the escape of the air; it also, by the amount of unsaturated plaster, permits the operator to gauge the stiffness of the batter.

In all cases the face of the model is the part first made. The thin freshly-mixed plaster is first to be carefully run into the depressions of the teeth or their ridges. A brush or feather is necessary when the tray is stationary; when in the hand, motion or tapping or jarring will cause the plaster to flow as desired. Perhaps the surest way to prevent defects on the face, from confined air, is to have a little surplus water in the tray. The plaster (which in this case must not be too thin) settles at once into the smallest crevice under the water, and if not stirred, it will not be made thin and rotten by it; or the plaster-batter may force the water before it until the latter escapes at the heel of the impression.

The impression once filled, the formation of the body is easy. For

deep models, the remaining plaster should be poured at once, that, while thin, it may form a smooth and level back. For shallow models the plaster must slightly stiffen, lest the weight of the impression should make it settle too much into the plaster on the table. The sponge is very useful in dressing up a model; it cuts more or less according to the state of the plaster. It may be used to trim vulcanite models directly after the spatula, or to give finish to other models after the use of the knife. But when plaster is fully hardened it has no effect.

Figs. 942 and 943 represent upper and lower models suitable for sand molding; the same may be used for dipping. Fig. 944 represents a shallow model in the molding flask, showing how the body of the die is formed by the zinc half of the flask. The same figure may be taken to represent the position of the thin model at the bottom of an iron tray, in the process of making the counter-die by Dr. Gunning's method.

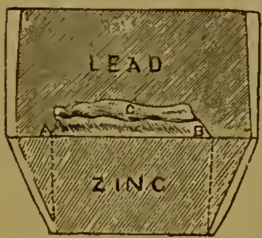


FIG. 944.

Difficulties arising from undercuts, on the outside of the upper ridge and on the inside of the lower, may be overcome: (1) by filling up the undercut with wax or plaster in all places where it is unnecessary or impracticable to carry the metallic plate; (2) by using a peculiarly-constructed flask for molding, such as the one invented by Dr. G. E. Hawes (Figs. 950–952); (3) by filling the undercut with movable pieces of plaster, technically known as "false cores." They should be so shaped as to admit of being drawn from the sand; at the same time they must have a decided angle, so as to mark distinctly the place in the sand for their replacement. A small nail or tack in the sand, above the core, will keep it in place while the metal is being poured. (4) By making a sectional model (Fig. 945), as suggested by Dr. A. Westcott. It may be made by filling the central third of the wax impression with the plaster, keeping it from the lateral thirds by a temporary use of clay or putty. This is removed and trimmed, leaving the back wider than the face (Fig. 945); then replaced in the impression and filled up on each side with plaster; the model is then removed, properly trimmed, and varnished.

Dr. Bean's method of making a model in two parts is equally applicable to making models in three parts, and is perhaps better than the foregoing. He thus described it: "To secure a division in the model itself, the best plan is to set up in the impression a septum of thin sheet lead, forming a vertical plane in the median line of the palate, and fitted somewhat to the inequalities of the impression. This plate should have two or three small projections struck up on one side, by

means of a small conical punch, and the opposite side has some cotton fiber attached with shellac, in the manner described for preparing impression trays. Fig. 946 represents the shape of this plate (one-half the size), and shows the side on which are the projections. Its proper position will be readily understood when applied to an impression of one of those deep palates now under consideration. The side having the projections is oiled, the cotton on the other side wet with water, and while filling up the impression, this plate is set up in the middle, along the median line, so that when the model is trimmed to proper size and shape, it may be carefully broken apart and placed together again in the same position."

Much time may be wasted in the effort to overcome difficulties of undercut in sand molding. The dexterous removal of shallow models will suffice for most cases of front undercut; and of all others, it may

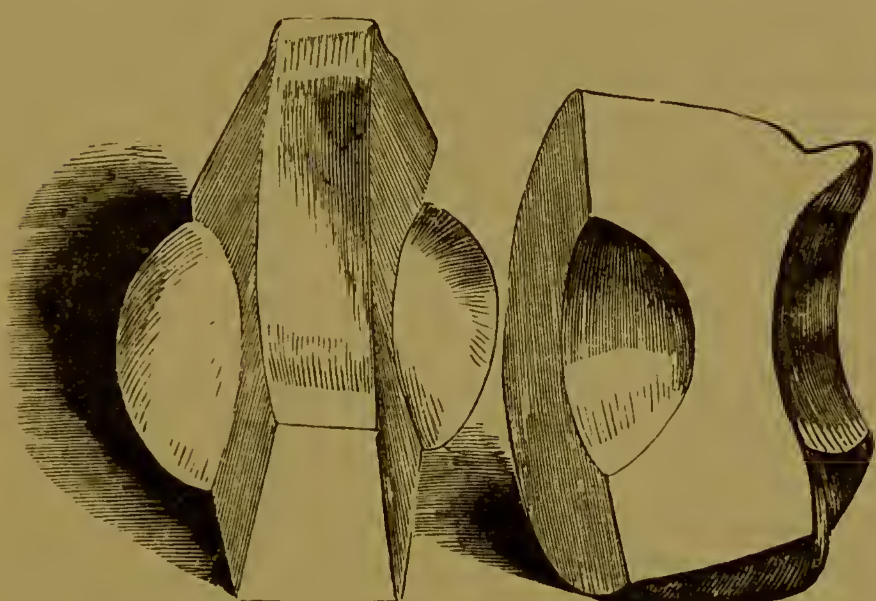


FIG. 945.

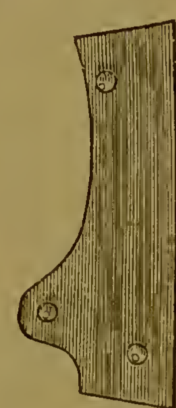


FIG. 946.

be said that no undercut on the die is of any service into which the plate cannot be swaged, or in removal from which the plate is apt to be bent.

Removing the impression is a fruitful source of vexation, because of the frequent breaking of prominent parts of the model and other annoying accidents. But these are in every case the result of haste, carelessness, or forgetfulness. First, the model must have time to harden; then the impression, if of wax or gutta-percha, must be thoroughly softened. The common practice of setting the model on the stove is bad; the smell of burning wax is often the first warning of a softening which has gone too far, injuring the model by the absorption of melted wax. It is far better to place it in water at 140° and 150° Fahrenheit, leaving it long enough for the entire mass of wax to

soften; at this temperature the wax does not melt, yet is so soft that it cannot injure the most delicate point of the model. If over 150°, some portions may adhere to the model and give trouble in removing. Gutta-percha impressions must be thoroughly softened in water at 200°; if over this temperature, portions of gutta-percha are apt to adhere to the surface. In partial cases it is a good plan to first remove the tray, then turn up the edges of softened wax or gutta-percha, till it is free from the teeth, and then remove the entire mass.

Plaster impressions require a different treatment. If the tray is wholly or partly of wax or gutta-percha, these must first be softened and removed; a Britannia tray is loosened by light strokes of the plaster knife handle. The impression is then broken away piecemeal. Dipping it in hot water makes it rotten, and facilitates, at times, its removal. It is often necessary to cut nearly through the impression in places, in doing which the knife or graver must be held so as to guard against injury to the model beneath. Another safeguard is to coat the impression, before pouring, with oil colored by alkanet; or, better still, to tinge the plaster with which the impression is taken with vermilion or Brandon red; it gives the dry plaster a faint pinkish tinge; does not, in this small proportion, injure its setting qualities; and it makes a very distinct contrast with the pure white of the model.

Few impressions can be used twice; those taken in wax or gutta-percha trays, never. Partial impressions of all kinds are necessarily sacrificed to the integrity of the first model. But plaster impressions, in a smooth Britannia tray, may, with proper care, be replaced in the tray, and used again so as to give a model quite equal to the first. Some of these will come from the model entire; but often it is necessary to cut a groove over the alveolus, and break off the outer rim in two or three sections.

Models may be partly trimmed before removing the impression, but it is always necessary afterward to trim the shoulder. Usually this is done by merely taking off the rough edges, following the outline of the edge of the impression; but for striking up a plate with the outer edge turned up, a flange, or shoulder, about the fourth of an inch wide, is formed around the outside of the plaster model, where it is designed that the edge of the base plate shall terminate on the alveolar border. It may be shaped either in wax or plaster, and should stand off from the ridge at an angle of about 90° or 100°, the angle of the rim being completed with pliers after swaging. A plate swaged with such a rim is used in mounting gum or block teeth and in continuous gum work; it is stronger than a simple plate, and is susceptible of a more beautiful finish. For a lower set of block teeth the edge of the plate may also

be turned up all the way round. An objection to a swaged rim is the occasional difficulty of determining just how far over the ridge the plate should extend; for any change is impossible without destroying the rim. Hence the more common practice, except in continuous gum work, is to solder a gold band or wire, after adaptation of the plate to the mouth, as hereafter explained.

The model, if it is to be used in sand molding, should have several coats of shellac or sandarach varnish applied with a small bristle brush, to give it a smooth, hard, and polished surface. This will protect it from injury by use, render it more pleasant to handle, and cause the sand to part easily from it. The gum shellac varnish may be prepared by dissolving five ounces of shellac in one quart of alcohol. In using this varnish on a damp impression, be careful not to apply a second coat until the first is hard, else it will cause the first to peel and injure the smoothness of the surface. Sandarach varnish is preferable to shellac, as it is harder; it is also more transparent, and, consequently, does not color the plaster. It may be made in the following manner: Take six ounces of gum-sandarach, one ounce of elemi; digest in one quart of alcohol, moderately warm, until dissolved; or the sandarach alone may be used. This is, perhaps, as good a varnish as can be used for plaster models. It is easily prepared, but the alcohol should be warmed in a sand bath or hot water, to prevent it from taking fire. To make the finest varnish, the sandarach should be of best quality, and washed in water before being put into the alcohol. Some, however, prefer a coating of charcoal dust or plumbago or powdered soapstone for sand models.

Models for dipping or pouring, or the fusible-metal process, should have no kind of varnish upon them. Vulcanite and other plastic work models may have a protecting coat of dilute soluble glass (nine parts water to one part of the glacial syrup); but if too much or too strong a solution is used, it will do more harm than good. No shellac or sandarach varnish should be applied to plaster models for either vulcanite or celluloid work.

For the preparation of the surface of the plaster model to overcome the difficulty resulting from a hard ridge or prominence in the center of the palatal portion, the reader is referred to page 846.

CHAPTER IX.

DIES AND COUNTER-DIES—SWAGING PLATES.

VARIOUS methods have been adopted for procuring metallic dies and counter-dies. The three following are all which the author deems it necessary to describe. The first of these consists in pouring melted metal into a mold or matrix, made in sand with the plaster model. By this means the die is formed, and the counter-die is obtained by pouring metal upon it. The second consists in making the counter-die first, either by immersing the plaster model in metal or pouring metal upon it; the die is formed by pouring metal into this.

The third consists in pouring the metal for the metallic die directly into the impression. A very ingenious set of flasks for this purpose, the invention of Dr. F. Y. Clark, can be had at the dental depots. The same may be done, less conveniently, perhaps, with the usual Britannia trays and molding rings. Take a piece of copper or brass gauze, and fit into the tray before taking the impression. Set the impression, thus strengthened, into a batter (asbestos or sand three parts, plaster one part), poured into a narrow iron ring (sheet iron will answer); carefully work the batter around the edges of the impression; then place upon it the zinc-molding half of a Bailey flask (Fig. 947).

FIG. 947.

If the impression is thoroughly dried, the first metallic die will be perfect, no matter how much undercut there may be. A second or third may then be taken, more or less defective, but very useful for the first stages of the swaging process. Zinc is the metal used by Dr. Clark for the die. In this process the impression may be plaster or plaster and feldspar; but the investing batter should have only enough plaster to bind the asbestos or sand together. Dr. Clark uses a copper impression tray, which Prof. Austen's process dispenses with. The flask and impression must be perfectly dry, and heated nearly or quite up to the fusion point of the metal used.

The second method admits of three modifications: 1. The *fusible-metal* process; in which the model is surrounded with thick paper, and fusible metal in a semi-fluid state is dashed over it with a spoon, the model being cold, so as to rapidly chill the metal. While still warm, the paper is removed and the counter-die trimmed with a knife; for at this temperature it can be cut as readily as cheese. The counter-die, when cold, is then smoked or coated with whiting, surrounded with paper, and semifluid fusible metal dashed on it, to make the die.

This process is repeated until from two to six dies are made, according to the irregular.:y of the case. The model should be in a ring of nearly circular s.iape and cylindrical; it should also be at least half an inch larger than the alveolar ridge, that the counter-die may have sufficient metal to fo. - up the plate.

2. The *dipping* process consists in pouring melted lead, type-metal, or pewter into a sheet- or cast-iron cup or box, three and a half or four inches in diameter and three or four inches deep, until it is more than half full; then, stirring the fluid mass with gradually increasing rapidity until it begins to granulate, quickly brush off the surface dross, and at once immerse the plaster model more or less deeply, as the palate is a deep or shallow one, and hold it there until the metal congeals. To prevent accident from air confined in the palatine arch, a small hole may be drilled through the plaster model. It is then removed, and the whole upper surface of the counter-die covered with a thin coating of whiting or lamp smoke, as before directed. After this has become perfectly dry, melted block tin, type metal, or soft solder, at a temperature so low that it will not char, or even discolor white paper, is poured in, until the cup is filled. If the counter-die is so deep that the die has not sufficient thickness, it may be deepened by placing on the freshly poured metal the zinc half of a Bailey flask, and continuing to pour; the metal in the two flasks will unite and form one die. When cold, the castings are removed from the iron cup, separated, and are then ready for use.

3. *Dr. Gunning's* method, called also the "pouring process," in which a very thin model (made of plaster two parts and sand or feldspar one part) is placed in the bottom of an iron box, three and a half to four inches in diameter and about two inches deep. It is fastened there by a thin layer of plaster and sand, then thoroughly dried by gradually raising box and all to the temperature of the melted metal, which is next poured in, and the box set in a shallow vessel of water to cool it rapidly from the outside. To delay the cooling in the center until the last moment, and to prevent contraction at that place, a very hot pointed iron, somewhat similar in shape and size to a tinner's soldering iron, is placed upon the center of the model before the metal is poured. When cold, this is removed and the conical space filled with metal. The counter-die is thus made of lead, alloyed with tin or type metal. The die is made by placing over this a stout wrought iron ring and pouring in fusible metal. Dr. Gunning uses from three to eight dies, according to the sharpness of the prominences of the model. The method gives, in his hands, very accurately fitting plates.

When metallic dies are to be obtained by the first method, molding

flasks and sand are required. Flasks may be of wood or iron. The molding box of wood should be about six inches square. This is to be filled with fine sand, such as is used by brass founders, in the following manner: The deep or shallow plaster model is placed on the molding table, exactly in the center of the box, with its face upward. Sand is then firmly packed around the sides of the model. Sand should then be sifted, covering the face of the model to the depth of half an inch, the box then filled, and the whole rammed with a firmness proportioned to the coarseness or dryness of the sand—damp or very fine or strong (*i. e.*, with large percentage of clay) sand not permitting so much compression as sand possessing the opposite qualities, because it would become too compact to permit the escape of the vapors formed during the process of pouring. But the finest sand, rich in clay and quite moist, may be used if it is dried before pouring. Sand mixed with olive or sweet oil possesses some advantages over that mixed with water, as it can be used a number of times without remixing, prevents the bubbling common to sand made too moist with water. The sand should never be burned by pouring on it very hot metal; hence it is better to stir the metal until it has cooled somewhat before pouring it into the mold. The metal should not be injured by overheating. Cooling the die suddenly in water renders it brittle.

The box is then turned over and gently tapped several times with some light instrument or hammer, for the purpose of starting or detaching it a little from the matrix, and then carefully removed. Great care is necessary that this tapping does not depress first one side and then the other; this would make the die too deep in the center, and perhaps cause the plate to rock. The model may be loosened laterally, by holding an excavator firmly upon the center of the die and tapping it on the side. If the model be composed of three pieces, the middle section is first removed, and afterward the two others. There are two ways of drawing the model: first, by screwing into it an excavator or gimlet, and carefully drawing it out; second, by throwing it out with a dexterous jerk of the matrix. The last is best; the excavator is apt to break through the center of the thin model, and the thick one falls out by its own weight better than it can be drawn. Fig. 948 represents the two ends of a double spatula, which will be found very useful in sand molding.

If the deep model is used, the matrix is now ready for pouring; but first remove all loose sand, and make a groove at the back part of the matrix to receive the first flow of the metal. If the thin model is used, a ring must be set upon the sand after the model is drawn, to give the additional size which the die requires to prevent cracking under the swaging-hammer.

The mold being prepared, the metal to be employed for the casting should be put into a tolerably thick wrought or cast-iron ladle and melted in a common fire or furnace. Mr. Fletcher has invented a very useful melting apparatus, which is also suitable for drying and boiling purposes. If brass is used, a blast furnace will be required to melt it; but if zinc, block-tin, or lead, a common fire will afford sufficient heat. As soon as the metal has become thoroughly melted it is poured

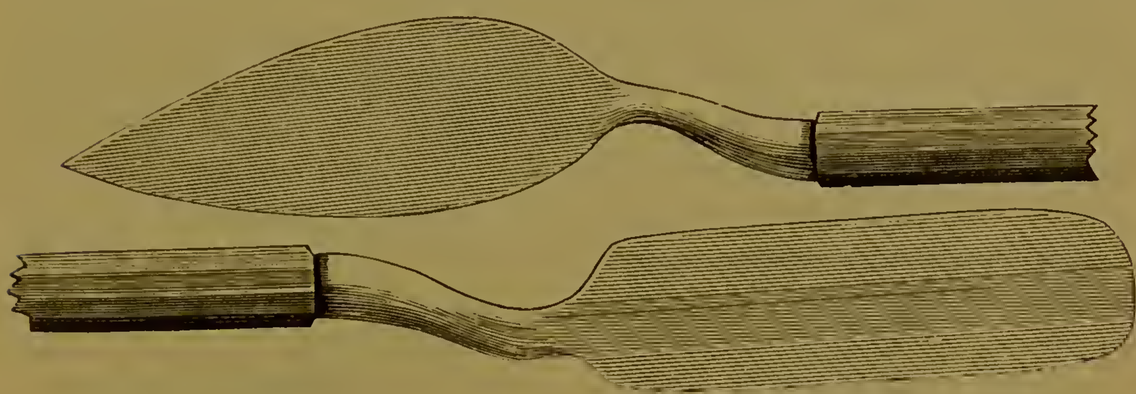


FIG. 948.

into the furrow formed in the sand, whence it will flow into the back part of the mold. It is necessary to convey the melted metal into the mold in this way to prevent the injury which the surface of the sand might sustain by pouring directly upon it.

There have been quite a number of molding flasks devised to supersede the wooden one just described or the common cart-wheel box, which was once much used. Some of these are worse than useless; others are very convenient, and have the advantage of requiring only

A B C

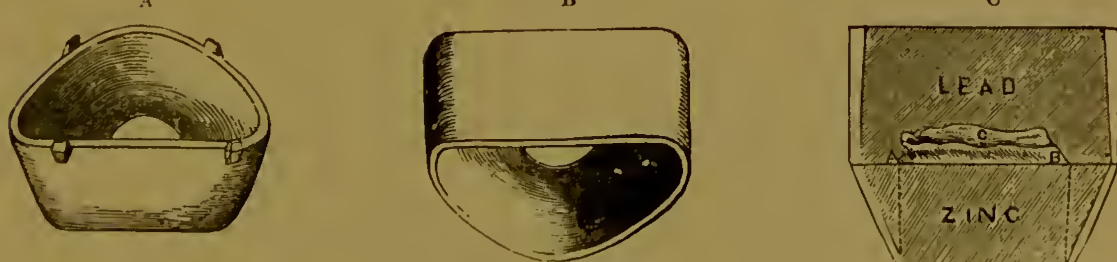


FIG. 949.

a small quantity of sand; also of permitting the sand to be dried, which cannot well be done in the wooden box. The simplest and perhaps best flask is that invented by Dr. E. N. Bailey. Fig. 949 represents the shape and working of this flask.

Half flask B is placed, joint-edge downward, over a thin model, and firmly packed with sand. It is then turned; the sand compressed around the edge of the model; then trimmed, so that the model may be easily drawn (a properly shaped model renders much sand trim-

ming unnecessary); the model is then lightly tapped and thrown out. All operations on the thin model must be conducted with great care, for it is easily displaced in its matrix, so as to destroy the accuracy of the latter. Next, pour zinc into the mold, and at once place on half flask A, and complete the pouring. When cool, remove the sand, invert the flask, with zinc die contained, and pour the lead (C) upon the zinc for the counter-die.

In cases of moderate undercut in front, the thin model can generally be drawn by a dexterous backward movement. But for a deeper undercut in front, also for those at the side, the molding flask of Dr. Hawes (Figs. 950, 951, 952) will be found useful. In Fig. 950 the lower section of the flask is slightly opened to show joints. In Fig. 952 the upper section. In Fig. 951 the lower section is closed and confined by a pin, with the plaster model placed in it.

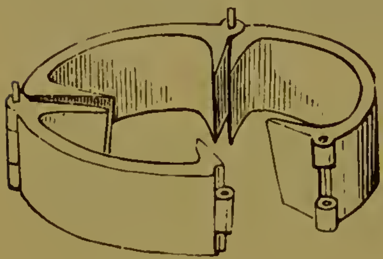


FIG. 950.

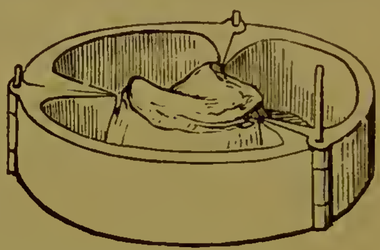


FIG. 951.

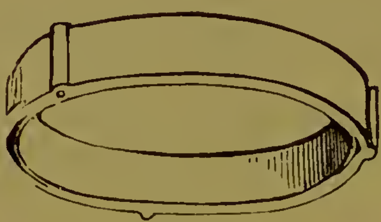


FIG. 952.

The manner of using is thus described by Dr. C. C. Allen: "If the model be considerably smaller than the space between the flanges projecting inward, small slips of paper may be placed in the joint, extending to the sides of the model, so as to part the sand when opening the flask for the removal of the pattern. The sand may now be packed around the model up to the most prominent part of the ridge. It should be finished smoothly around it, slightly descending toward the model, so as to form a thick edge of sand for the more perfect parting of the flask. The sand and face of the model must now be covered with dry pulverized charcoal, sifted evenly over the whole surface. When this is done, the upper section of the flask is placed over the lower and carefully filled with sand. It is then raised from the lower one, which may now be parted by removing the long pin, and the model gently taken away. When closed, and the two put

together again and inverted, it is ready to receive the melted metal." After the metal has cooled, it may be removed and turned over, so that the face of the die shall be upward, while the remainder is buried in the sand. Thus placed, it is encircled with the ring (Fig. 952) and the metal for the counter-die poured upon it.

The metals most commonly used, when metallic dies are made by sand molding, are zinc and lead. For many reasons these are, perhaps, the best metals for general use that can be employed. Zinc is the hardest metal that the dentist can conveniently melt. In case of deep or large arches, and for mouths where the mucous membrane is very hard, should its shrinkage prevent the close adaptation of the plate, a finishing die may be made of block tin, type metal, soft solder, or Babbitt metal (a patent alloy of copper, tin, and antimony, the best formula for which is Dr. Haskell's: copper, 1 part; antimony, 2 parts; tin, 8 parts), which last is nearly as hard as zinc and has decidedly less shrinkage. When a metal softer than zinc is used, several dies will be necessary to complete the swaging. As this Babbitt metal fuses at a lower temperature than lead, it is necessary to use a counter-die in which tin forms a part; Dr. Haskell therefore recommends the following formula: lead, 5 parts; tin, 1 part. The die should be coated with whiting solution before pouring the counter-die.

The late Prof. Austen, by careful experiment, found that an average-size zinc die, measuring two inches transversely, contracts $\frac{27}{1000}$ of an inch from outside to outside of the alveolar ridge, being equivalent in thickness to three ordinary book leaves. He remarks: "In the first case (upper jaw), the plate would 'bind,' and if the ridge were covered by an unyielding mucous membrane, it would prevent accuracy of adaptation. In the second case (upper jaw), the plate would have too much 'play,' and consequently lack stability. Again, in a moderately deep arch, say half an inch in depth, the shrinkage between the level of the ridge and the floor of the palate will be nearly $\frac{7}{1000}$—rather more than one leaf. In the deepest arches this shrinkage may give trouble, except where the ridge is soft, and then it becomes a positive advantage. In the shallower cases, it is not of much moment, as there is no mouth so hard as not to yield the $\frac{1}{1000}$ or $\frac{2}{1000}$ of an inch."

A counter-die should be soft. When but one metal is used, lead is decidedly the best metal for this purpose; tin may also be used if the die is made of zinc, but tin counter-dies are only employed for the final swaging, and after the use of lead counter-dies. It is desirable, if practicable, that the metal last poured (in sand molding, this is the counter-die) should melt at a lower temperature than the other. In this respect zinc and lead are admirably suited—zinc melting at 770° and lead at 600°. Tin melting at 440° might be supposed, in this

respect, better than lead; but such is not the fact, owing to the tendency of tin and zinc to form alloys, while lead and zinc have no such affinity.

The requisites for a die are non-shrinkage, hardness, strength, smoothness of surface, and fusibility at a low temperature. The Babbitt metal after the formula before given furnishes such qualities.

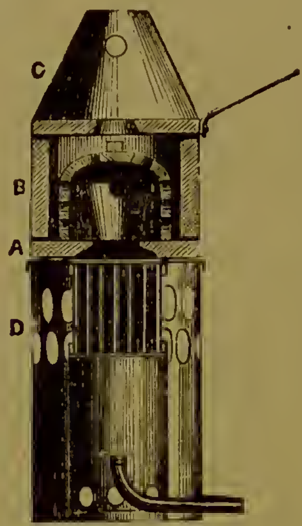


FIG. 953.

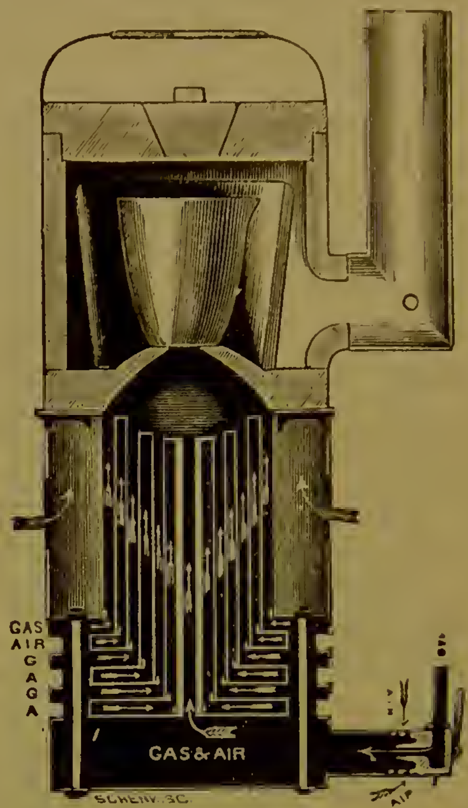


FIG. 954.

Fig. 953 represents an excellent gas furnace for melting and refining gold and other precious metals and for melting zinc, lead, etc., of the baser metals. Fig. 954 represents a sectional diagram of the same furnace. In using plumbago crucibles, etc., they must be heated slowly when first employed. Mr. Fletcher's small gas furnace, which is well adapted for melting the metals

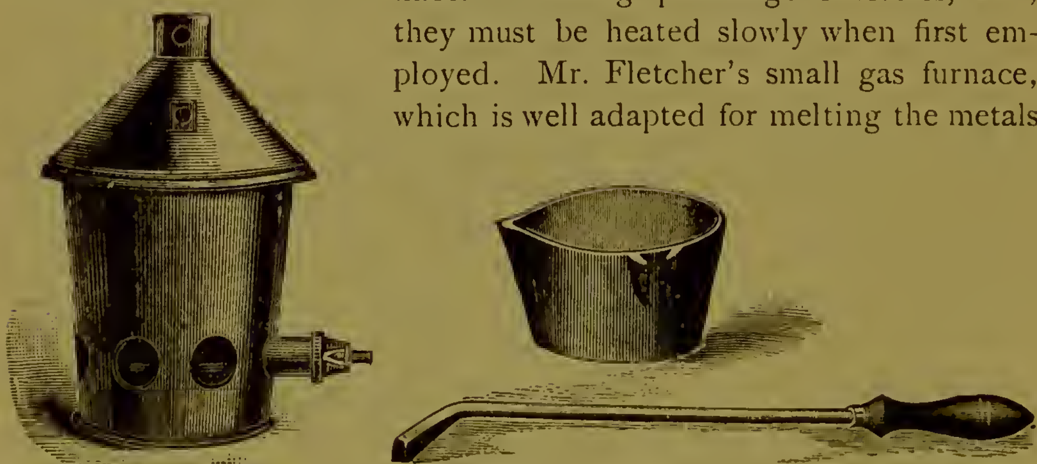


FIG. 955.

employed for dies and counter-dies, is represented by Fig. 955.

In a paper on metallic dies, published in the fourth volume of the *American Journal of Dental Science*, Prof. Austen gives, as the

result of careful experiment, the following tabular view of the fusible alloys—zinc being introduced for the purpose of comparison :—

	Melting Point.	Contractility.	Hardness	Brittleness.
1. Zinc, ...	770°	.01366	.018	5
2. Lead, 2; tin, 1, ...	440°	.00633	.050	3
3. Lead, 1; tin, 2, ...	340°	.00500	.040	3
4. Lead, 2; tin, 3; antimony, 1, .	420°	.00433	.026	7
5. Lead, 5; tin, 6; antimony, 1, .	320°	.00566	.035	6
6. Lead, 5; tin, 6; antimony, 1; bismuth, 3, ...	300°	.00266	.030	9
7. Lead, 1; tin, 1; bismuth, 1, . .	250°	.00066	.042	7
8. Lead, 5; tin, 3; bismuth, 8, . .	200°	.00200	.045	8
9. Lead, 2; tin, 1; bismuth, 3, . .	200°	.00133	.048	7

The last column contains an approximate estimate of the relative brittleness of the samples given. As in the other columns, the low numbers represent the metals, so far as this property is concerned, most desirable. Those marked below 5 are malleable metals; those above 5 are brittle; zinc, marked 5, separates these two classes, and belongs to one or the other according to the way in which it is managed.

In all cases of melting it is a safe rule to pour the metals at the lowest temperature at which they will flow. It is prudent, also, to coat the metal on which other metal is poured with a mixture of alcohol and whiting, to prevent all chance of adhesion. One more very important caution in the melting of zinc and lead is invariably to use separate ladles; for any lead left from a previous melting flows from the ladle with the last portions of the zinc, and, being heavier (in the proportion of 11 to 7) and more fluid, falls at once to the bottom of the matrix, making the alveolar ridge more or less of a soft metal, thus totally destroying its usefulness.

The elastic vapor generated by the contact of the water in the sand with the hot metal sometimes collects under or rises through the metal, and renders the casting more or less imperfect. This may be prevented: 1, by drying the sand; 2, by using coarse or loosely-packed sand and avoiding too much moisture; 3, by mixing the sand with oil instead of water. The slightest moisture on one metal, previous to the pouring of another metal upon it, will make the latter imperfect. The following method has been suggested to overcome this difficulty: "To prevent imperfections or bubbles in the palatal portion of metallic dies, it is not necessary to dry the mold after it is formed, or to use more than ordinary precaution as to the heat of the

metal. The best result is obtained when the plaster model is quite thick and the mold consequently deep. This is then tipped forward, raising the back part or condyles to the highest point possible, pouring the metal in at the front slowly, and lowering the mold at the same time until the palatal portion is covered and the mold filled to the top." The use of oiled sand, however, as before remarked, will prevent imperfections by bubbling on the palatal portion of the die.

In making metallic dies for partial cases, about three-fourths of the crowns of the teeth should be cut from the plaster model before using it for molding. The plate can be fitted more easily and perfectly than can be done when the teeth remain on the plaster model and zinc die; for, in the former case, the plate need not be cut to fit the teeth until it has been swaged; while in the latter this must be done first; consequently, in striking it up, it will be drawn to a greater or less distance away from them. There is also danger of splitting the plate, in swaging it into the spaces between the teeth, if these are left on the metallic die. Half or partial counter-dies adapted to the palatal portion of the die only, and not extending quite to the ridge, are useful in the case of a deep arch, and prevent the plate from tearing during the swaging process.

We shall conclude the section on metallic dies by giving some practical suggestions by Prof. Austen on the properties and uses of the metals and alloys employed for this purpose.

Many of the properties of these metals, though most interesting, are not practically useful to the dentist; but there are some points, for which he usually refers to his memorandum book, that should be printed on the page of his memory. The following tables present two properties of certain metals in a form convenient for memorizing; although not absolutely accurate, they are quite enough so for use in the dental laboratory:—

Order of Fusibility.		*Order of Specific Gravity.*	
Copper,	2000°	Lead,	11.5
Antimony,	900°	Bismuth,	10.
Zinc,	770°	Cadmium,	8.5
Lead,	600°	Tin,	7.5
Bismuth,	500°	Zinc,	7.
Tin and cadmium,	440°	Antimony,	6.5

In the fusibility table, copper is given to show how unsuited it is for laboratory use. Remembering that 900° is *red heat*, the next four numbers may be easily memorized. In the specific gravity table, copper 9. and iron 8. are omitted, so as to present the table in a form easily remembered.

The only pure metals suitable for a die are zinc and tin; for a counter-die, tin and lead. When one metal is used for either die or counter-die, zinc makes the best die and lead the best counter-die. Copper is too hard to fuse; antimony and bismuth are too brittle; cadmium is too expensive. All other metals used in swaging are alloys.

Zinc and lead are valuable because: They are so unlike that they are not easily mistaken for each other—a very common error when alloys are used. They have no such disposition to alloy as zinc and tin or tin and lead have. Zinc is so hard, one die will suffice for many cases; three are sufficient for the most difficult. The brittleness may be corrected by the size of the die. Its shrinkage is often a decided advantage; and in some cases, where it makes the plate bind on the alveolus, the contraction may be anticipated by coating these parts on the model with one or two layers of very thin plaster. Zinc, after repeated use, becomes defective, hence, a supply of new metal should always be kept.

No metal used alone equals lead as a counter-die. Its weight and softness are in its favor for this purpose. A counter-die cannot be too large or heavy; convenience, of course, limits its size. A difficult plate cannot be swaged with a small counter-die, unless the work is nearly completed by partial counters, hammers, etc., before using it. As regards softness, the greater the disparity between die and counter, the less will be the change in the die by the act of swaging. The plate is forced by the counter into the depressions of a die, not so much by its hardness, as by its *vis inertia* under the swaging blows. The little disparity in the hardness of the two dies is one serious objection to the use of the second class of operations. It is a common practice to use several counters, and perhaps only one die. One die may in a few cases suffice; two are better, and often three; but good swaging never demands more than one counter-die, where that is properly made.

With zinc, lead, and one fusible alloy (tin and bismuth, equal parts, or Babbitt's metal) all swaging operations may be completed when the dies are made by sand molding or by pouring zinc into the impression. But since many prefer other methods of making dies, it is important to understand the subject of alloys. Experiment is here the only basis of knowledge, for no *a priori* reasoning could deduce the singular changes caused, and new properties developed, by alloying.

The alloy of two brittle metals is always brittle, and a brittle metal usually imparts this property to a tough one nearly in proportion to its percentage. But that two tough metals can make a brittle alloy is remarkable. Malleable copper, with half its weight of brittle zinc, gives hard brass, which, though less tough than copper, is not brittle.

But malleable copper, with malleable tin in the same proportions, makes speculum metal—the most brittle alloy known. A similar instance is that of lead, the softest of metals, which will, in minute quantities, make gold, the most malleable of all metals, very brittle.

Another remarkable property of all alloys is fusibility. Alloys fuse below the average melting point of their constituents. Ternary compounds exhibit this more strikingly than binary. The following table, in illustration of this property, will be found practically useful to the dentist in the selection of alloys:—

ALLOYS OF BISMUTH, LEAD AND TIN.

	BISMUTH, 500°.	LEAD, 600°.	TIN, 440°.	FAHRENHEIT.
1		10	1	540°
2		5	1	510°
3		2	1	440°
4		1	1	370°
5		2	3	335°
6		1	2	340°
7		1	5	380°
8	1	4	4	320°
9	1	2	2	290°
10	1	1	1	260°
11	2	1	1	220°

It will be noticed that two pounds of lead do not make one pound of tin harder to melt, whilst a half pound reduces its fusion point 100°. Also, Nos. 6 and 7, though containing more tin than No. 5, are harder to melt. Again, a pound of bismuth added to alloy No. 4 reduces its melting point 110°. No. 11 and all alloys containing much bismuth are brittle. The alloys of this table vary somewhat in hardness, but all are harder than tin.

The "alloying metals" of the dental laboratory are copper, antimony, and bismuth. Copper gives hardness to zinc and tin, and is sometimes combined with alloys of the two. But the high fusion point of copper renders it less useful to the dentist than the other two metals. The alloy of copper, antimony, and tin (Babbitt metal) is perhaps the only one of practical interest. Its advantage over zinc, in being less liable to contract, is perhaps set off by the tendency of most alloys to change their composition by frequent melting; and the danger of mixing different alloys, from the absence of such distinctive marks as separate zinc and lead.

Antimony is a more valuable alloying metal. It hardens tin, but its chief use in the laboratory is to harden lead, making type metal. Small types composed of lead 4, antimony 1, are too brittle; and large

types, lead 6, antimony 1, are scarcely fit for laboratory use. In the proportion of 9 to 1, antimony corrects the excessive contraction of lead and hardens it, yet leaves it tough, so as to resist the blows of swaging. It is suitable only for counter-dies.

The very common opinion that antimony causes lead to expand on cooling is erroneous. The alloy has a slight expansion at the moment of solidification; but after that it obeys the universal law of all metals, and contracts as it cools. Actual contraction depends upon the ratio of contraction and the fusion point; thus, lead contracts more than zinc because its high ratio of contraction more than compensates its lower fusion point.

Another common error is that a zinc die poured very hot is smaller than if poured at its fusion point. Of course, contraction begins the moment cooling begins; but so long as the metal is fluid it necessarily fills the matrix, and contraction causes simply subsidence of the metal. No die begins to leave the walls of the matrix until it solidifies; hence, the amount of contraction is the same in all cases. Very hot zinc copies minutely the sand surface, and thus has not that bright, smooth appearance of cooler zinc, which sets before penetrating the sand interstices; but both are equally good. Another difference is in the greater depth in the cavity on the back of the hot-poured die. But this is not as objectionable as many think; no good mechanic strikes directly upon the die, but upon some ovoid or conical piece of metal covering the cavity in the back.

Bismuth is perhaps the most valuable, to the dentist, of the three alloying metals. Antimony gives hardness, but not much fusibility; bismuth gives fusibility, but no great hardness. The table above given shows the marked effect of this metal. It is seldom used as a binary alloy, because its fluxing qualities are more fully brought out in ternary combination; also because of its expensiveness, and its tendency to impart brittleness. Type metal is rendered more fusible by the addition of .05 per cent. of bismuth.

Bismuth, antimony, and zinc are readily distinguished—bismuth by its great weight and characteristic pinkish color; antimony by its peculiar crystallization and its excessive brittleness. But the alloys of these metals with tin and lead have such a general resemblance, that they must, with much care and system, be kept apart in properly labeled boxes; otherwise, if more than one alloy is used, the annoyance caused by using one for another will more than offset their utility; in fact, such negligence defeats their usefulness.

But the formula of Dr. L. P. Haskell for preparing the Babbitt metal is superior to all others for use as a die: tin, 8 parts; copper, 1 part; antimony, 2 parts. For a counter-die for such a die: lead,

5 parts; tin, 1 part. He claims that such a Babbitt alloy for the die cannot be excelled.

Dr. C. J. Essig recommends zinc for a counter-die for swaging a plate of platinum-gold or iridium-platinum; and also that such a counter-die is of especial service in partial cases where a number of teeth remain. For difficult swaging he recommends three sets of dies and counter-dies, the most imperfect of the dies being furnished with a lead counter-die, to be first used, and the next in quality to be used with a zinc counter-die, and the nearest perfect of all with a lead counter-die as a finishing die.

SWAGING.

A die and counter-die having been obtained, a piece of tin foil or sheet lead is adapted to the former, and the dimensions of the plate marked upon it. Paper is sometimes used for this purpose, but is not so good as thin sheet lead or heavy tin foil. The pattern thus made is cut out, flattened, and laid upon the gold plate, and its outline marked upon it. The outline of the plate may be marked on the plaster model and the pattern cut in conformity therewith. The margins of the plate for the upper jaw should extend as high as possible, and especially over the position of the canine teeth, in order to restore the expression, which is greatly changed by the loss of the natural teeth at such points; back of the canine teeth the margin of the plate should be lowered so as to avoid the attachment of the muscles and to allow the latter free motion or action. The plate should also embrace the maxillary tuberosities in order to obtain stability, and the margins at such points may extend higher than over the bicuspids and first molars. The plate should be cut a little too large, to allow for trimming and any accidental slipping upon the die. In partial cases the pattern should be carried partly, or fully, over the excised teeth, and no attempt made to fit it accurately around the necks of the teeth until the swaging is nearly or quite completed. With a pair of strong shears the portion of plate thus marked is cut out. Fig. 956 represents a pair of shears, with long and conveniently-shaped handles. The blades of some shears are curved laterally; but this form is not desirable. A fine watch spring saw, Fig. 613 (p. 679), should be used for curves which the straight shears will not cut; curved shears may also be used for such a purpose; for very short curves—around teeth, for instance—a pair of cutting forceps will be found useful.

Fig. 956.

Figs. 957, 958, 959 represent nippers or cutting forceps for cutting out plate.

Cutting plates to shape before swaging is, however, not only unnecessary, but is in many cases a positive disadvantage. Swaging the

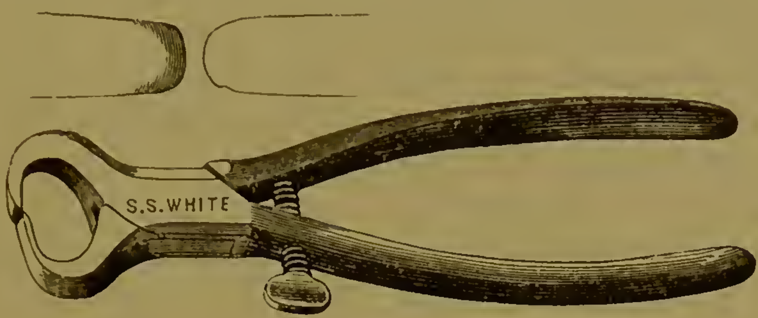


FIG. 957.

square plate is greatly preferable in the lower jaw, since it permits working from the center outward. And in both upper and lower plates, the two triangular pieces outside the ridge help to prevent plaiting, or doubling of the plate. Purchased plates are ordered to

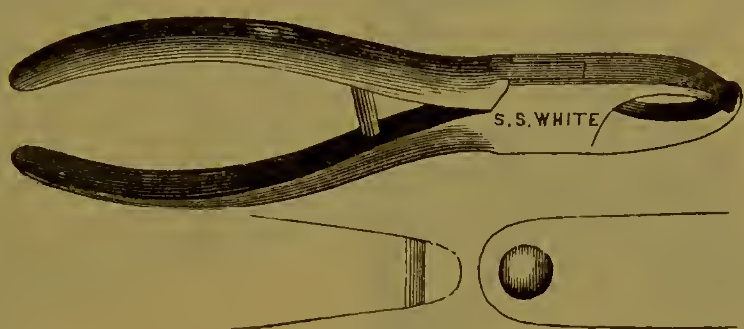


FIG. 958.

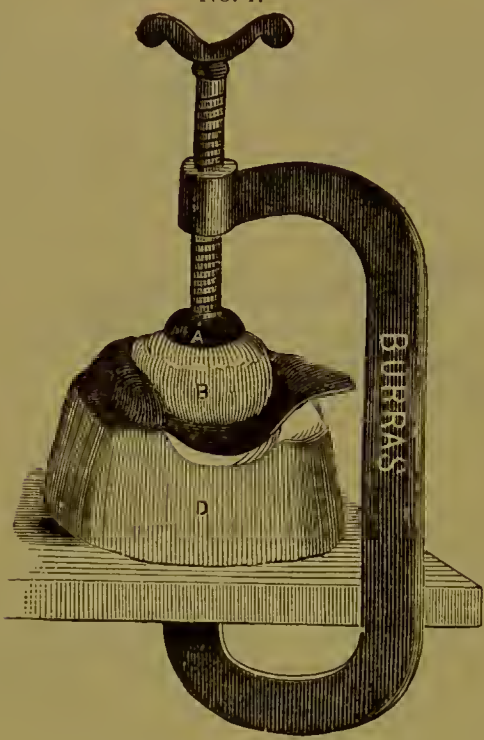
pattern on the score of economy; but the difference is trifling, since good plate scrap has nearly the same value as the original plate, and every careful operator separates his plate scrap from his solder scrap

FIG. 959.

and filings. After swaging is nearly completed, with partial counters and hammers, the square plate may be quickly trimmed to shape by means of a jeweler's saw.

The plate must be well annealed, and partially fitted by wooden, horn, or leaden hammers, to that part of the die inside the ridge. There is no better hammer for this purpose than lead; but, of course, the plate must be thoroughly cleansed of all trace of the lead before annealing. The swaging is continued by the use of *partial* counter-dies; these are made by placing a rim of clay or putty around the ridge and back part of the metallic die, and pouring on it fusible metal. In this way, the plate should be perfectly fitted so far as the ridge. Then, clamping the plate between the die and the partial counter, the edge is to be gradually carried over the top and outside of the ridge with hammers and small wooden or ivory stakes. The

No. 1.



No. 2.

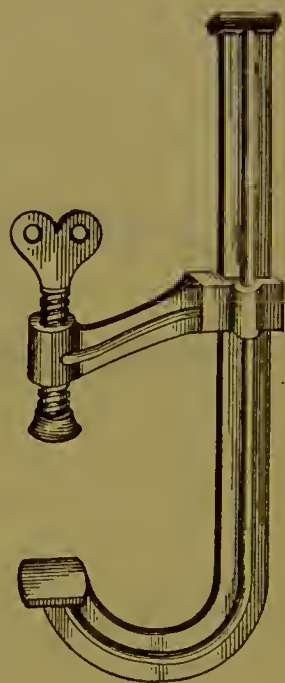


FIG. 960.

plate may be clamped in a vise, or by means of a string passing over the die and under the foot; but a much more convenient method is found in the use of Dr. T. H. Burras's clamps, Fig. 960. Of the two forms here given, the sliding arm (No. 2) is preferable to the long screw (No. 1). The application of the clamp is so plainly shown in No. 1 that any description is unnecessary.

It is the practice of some to cut out V-shaped pieces from the front or back part of the plate, to prevent the plaiting of the metal. This is very bad practice and is never called for, if due care is used in swaging and the metal is of proper fineness. To avoid plaits or folds, anneal often, and in deep arches carry the plate down very gradually;

also take care in such cases that the plate be thick, to allow for stretching or drawing. In swaging over the ridge, it is a very common mistake to hammer down the outside before fully striking up (with hammer and stakes) the parts nearest the partial counter-die. Always make it a rule, in carrying the plate over the ridge, to swage from the center outward, and carry the plate "home" as you proceed. In deep arches, irregular alveolar ridges, and in prominent lower ridges swaging must be done slowly and with great care.

In the use of forceps for bending lower plates (Fig. 961), care must be taken not to bruise the metal, as will any steel or hard metal instruments. There is no shape of arch or of plate which, by the above simple process, cannot be perfectly fitted with a 20-carat plate. The elaborate forms of a window cornice or a jelly mold should teach any dentist how poor a mechanic he is when he complains of the difficulty of swaging so highly malleable a metal as gold into and over the

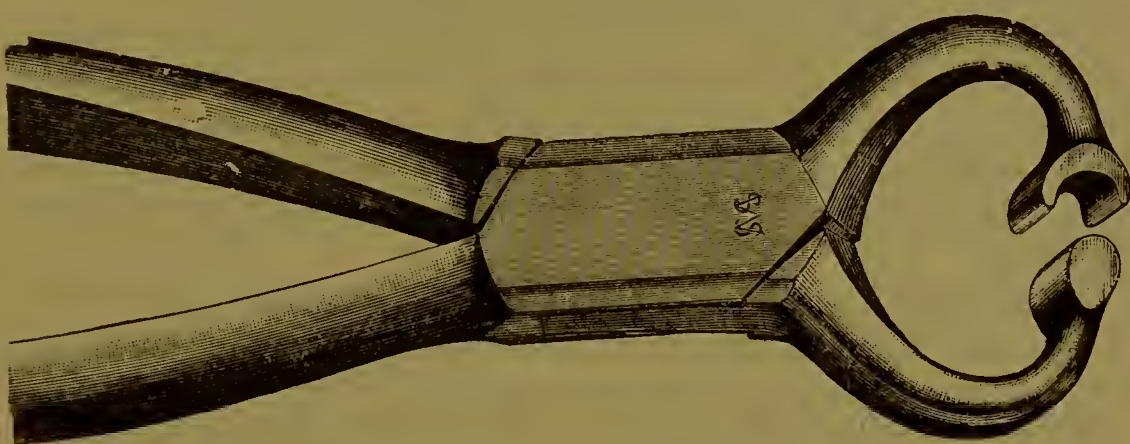


FIG. 961.

irregularities of the mouth. And when, to savė his skill, he pleads want of time, he exposes a graver deficiency—dishonesty.

The fitting of the plate being thus almost completed by hammers and partial counters, it should be trimmed to its exact shape, and then placed between a fresh die and the full counter-die, and carried "home" by several firm blows of the hammer, given directly over the center of the die. The hammer should not weigh more than three pounds, with a handle about a foot long. It is a great mistake to use a very heavy or a very long-handled hammer. The striking-block may be an anvil, or a large wooden block set in sand or on a cushion, and the base of the counter-die must rest steadily upon it. Dr. Haskell describes a movable swaging-block to be kept under the bench as follows: "Eight inches wide at the top, and eleven inches at the bottom, just high enough to pass under the bench. Make it of pine with a plank bottom, to which attach heavy casters, a handle on

one side, and a pocket for the hammer. Have an iron 6-inch cube cast, and, filling the box nearly full of sawdust, place the iron cube in it so it will extend two inches above the box." It greatly facilitates swaging, and makes one independent of any striking block, to have a very thick and heavy lead counter. As there is always a hollow in the back of a zinc die, a conical piece of iron, steel, or other hard metal should be placed upon it to centralize the blow of the hammer. An eggshell filled with plaster is useful as a model for making, at the time of molding the die, several zinc blocks for this purpose. To a disregard of these precautions is due much of the difficulty so often complained of in the tilting or rocking of plates and dies.

Throughout the entire process of swaging the plate must be frequently annealed. It may be suddenly cooled after all except the final annealing, when the cooling must be very gradual, so as to avoid warping or springing. The malleability of gold plate will permit a great deal of swaging without annealing ; yet the neglect of this simple operation is unsafe. One broken or cracked plate gives more trouble than the annealing of a dozen. The plate, after final swaging, must be taken from the counter very carefully, to avoid change of shape. Thin paper in the counter-die makes removal easier ; it is also easier when only one counter is used. Too much swaging gives the plate a loose fit.

When block-tin, lead, or fusible metal dies or counter-dies are used in swaging the plate, any portion of these metals which may adhere to it should be removed before annealing, as their fusion upon its surface alloys them with the gold, and will render it brittle and impair its ductility, or else eat holes in the plate at the spot where the particles of baser metal form an alloy, fusible at the annealing heat. This is done either by mechanical or chemical means. If acid is used, it should be dilute nitric, since sulphuric will not dissolve lead ; but be very careful that the nitric acid contains no hydrochloric, else the plate will be acted upon. A copper or lead acid-dish may be employed, many preferring one made of thick sheet lead. Oiling the dies will also prevent the base metal from adhering to the plate, as any particles of the former can be readily wiped off.

The plate, in the case of a full upper denture, should be so outlined as to have the highest portion of the rim over the cuspids, curving downward back of such points to the maxillary tuberosities, where it again should ascend so as to extend over these prominences. (Fig. 962) Space should also be made for the frenum of the lip by cutting away the edge or rim for its reception. In the case of a full lower denture, the bending pliers may be used first, and its outline should be such that it does not interfere with the muscles and loose integuments.

For a very flat ridge, the lower plate should be double to give strength, and for partial lower dentures it is better to double the plate where strength is required; strength is also secured by the plate, in such cases, extending above the necks of the teeth, in some instances half way, where the attachment of the muscles would otherwise necessitate a very narrow plate. Each piece of a double plate should be swaged separately, and the two parts then soldered together, wire clasps being

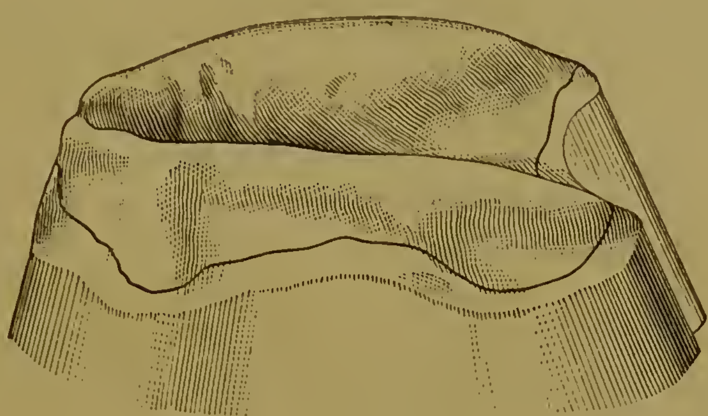


FIG. 962.

used to hold them in position during the soldering process. If the denture is to be retained by clasps, the plate, either upper or lower, should extend at least one-fourth of an inch beyond the clasped tooth in order to secure stability. In soldering the two parts of a double plate, the edges of one should slightly overlap the other so as to facilitate the process.

Figs. 963 and 964 represent the general forms of upper and lower

FIG. 963.

FIG. 964.

plates after the swaging process is completed. In the upper plate is represented the proper size and position of a vacuum cavity, according to area of mouth, whenever it may be thought proper to use one. The question of the cavity will be elsewhere discussed.

If on trial of the plate in the mouth it does not fit properly, the operator must proceed to ascertain the cause of failure. And, first, whether it is temporary or permanent. A plate which falls because it

rocks over a hard palate will never improve ; if because it fails to go fully into the palate it may daily improve, and ultimately adhere with great firmness. Most plates made soon after extraction fit badly until the alveolar prominences are pressed down by wear. Some very hard mouths will not retain the plate until it has been worn for a time, especially if the mouth is very flat. Deep arches, or uniformly soft mouths, should retain the plate firmly from the first.

The use of pliers, except for bending the edge into some alveolar undercut, is an evidence of bad work. The back margin of upper plates, so often adjusted in this way, is much better fitted by scraping the model at the place where the plate should bind ; this should be done to a depth proportioned to the softness of the membrane.

Much judgment is demanded in deciding upon the necessity for a new plate. The impression may have been badly taken, or with a material not adapted to the mouth. The dies may have been carelessly made, or the swaging imperfectly done. Trial of the plate is essential to ascertain all these points, that the articulation, soldering, etc., may not be so much additional labor in vain.

In fitting a plate, the operator should see that its posterior margin, especially at the center, is so closely adapted as to exclude air. Dr. Haskell recommends wetting the plate before placing it in the mouth, and then by a "pumping process" watching for the escape of air bubbles. At the same time the plate should not press so hard at the center of its posterior margin as to irritate the mucous membrane. To determine whether a lower plate infringes upon the muscles and lower integuments, the patient may be directed to raise the tongue, which will dislodge the plate if it so interferes by its depth. The lip can also be raised in front to determine if the plate extends too deep at that point.

The different forms of plates, full and partial, will hereafter be considered. They are retained in the mouth by clasps or stays ; by the adhesion of contact or by the vacuum cavity, the retaining force being atmospheric pressure ; by the elastic spring of the wings of the plate ; by spiral springs. These will be taken up in a subsequent chapter and their relative merits discussed. We pass now to the step which, in swaged work, comes next in order to the fitting of the plate—the means for securing its exact relation to the natural teeth, or, in double sets, its relation to the opposing plate. These processes come under the technical head of Articulation.